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Construction of the Wachusett-Coldbrook Water Supply Tunnel

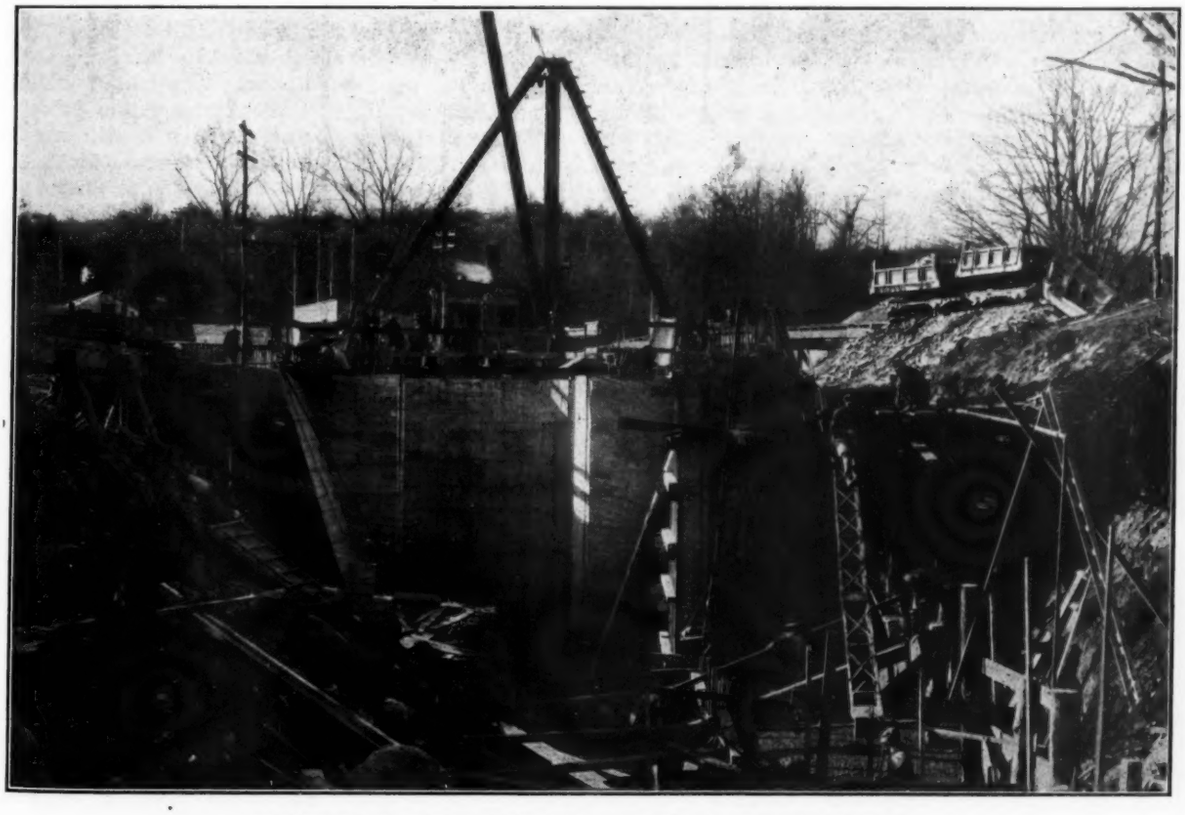
By Alfred Gargaro and Frank E. Fahlquist*

To provide for future growth and an increased consumption of water in the Metropolitan District of Boston, the Wachusett-Coldbrook Tunnel, 13.2 miles in length, is being constructed from the northwesterly side of Wachusett reservoir to the Ware river, near Coldbrook. The present supply is obtained from several sources which have been developed since the organization of the district, and includes the minor supplies of Lake Cochituate, Sudbury reservoir, Hopkinton and Whitehall reservoirs, and the present major supply of Wachusett reservoir, formed by impounding the flows of the Nashua river at Clinton.

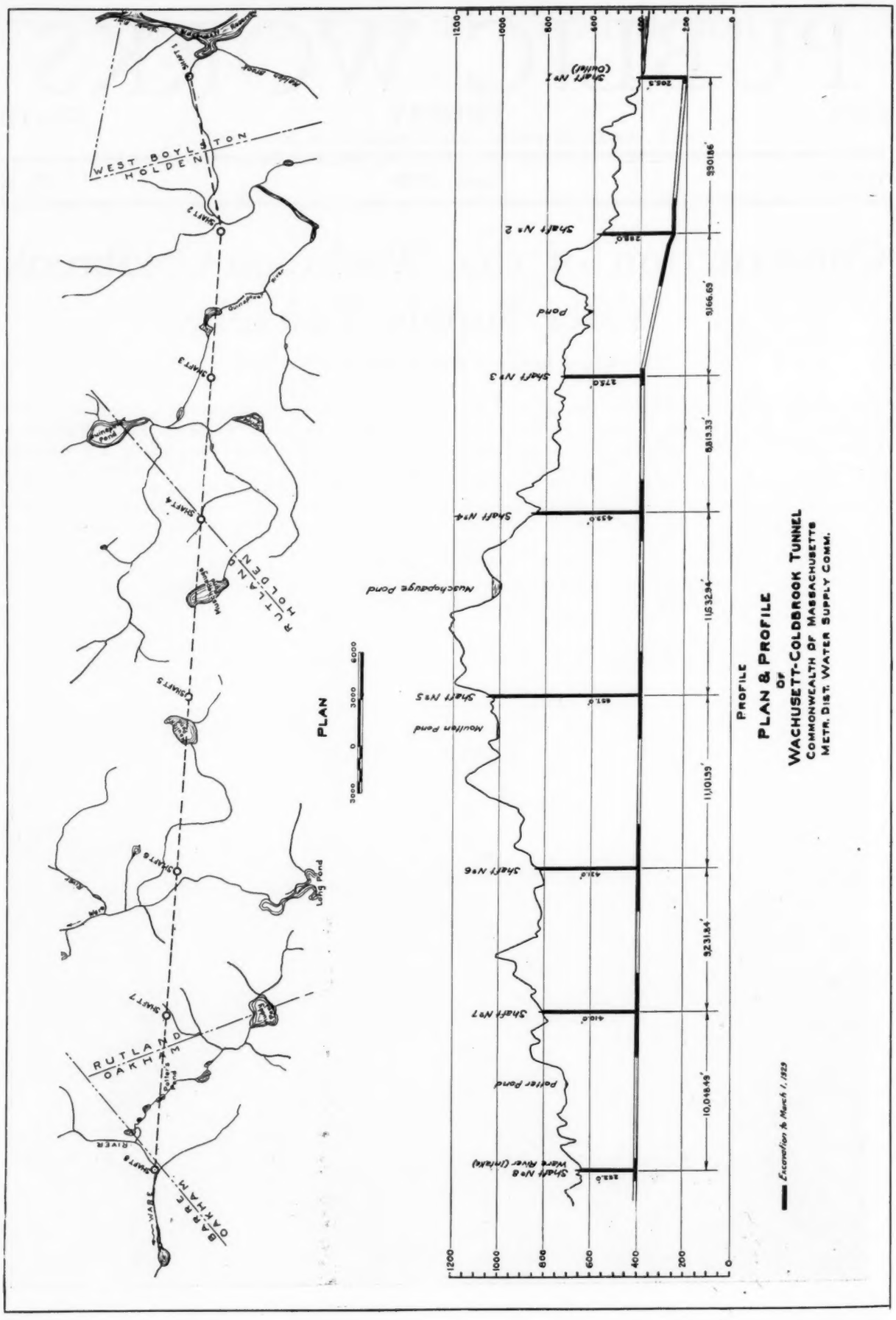
*Engineering inspector and assistant engineer, respectively, of Metropolitan District Water Supply Commission.

The new construction will carry the diverted flows of the Ware river to the Wachusett reservoir, the water ultimately reaching the consumer by a tunnel and aqueduct already in service. By law, the diversion is limited to those flows of the river in excess of 85 mgd, which limits the diversion to the freshet or flood flows from approximately 98 square miles of drainage area. This diversion is expected to yield not over 30 million gallons per day in addition to the Wachusett supply.

Surveys were started in November, 1926, and shortly afterward an extensive program of borings was begun to assure sufficient rock cover above the tunnel at all points, and to locate suitable shaft sites. These subsurface investigations revealed the fact that low rock



LOOKING TOWARD SHAFT NO. 1 FROM OUTLET CHANNEL


PLAN
PROFILE
PLAN & PROFILE
OF
WACHUSETT-COLDBROOK TUNNEL
COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMM.
WEST BOYLSTON
HOLDEN
RUTLAND
OAKHAM
BARRE
OAKHAM
SHAFT 1
SHAFT 2
SHAFT 3
SHAFT 4
SHAFT 5
SHAFT 6
SHAFT 7
SHAFT 8
Shaft No 1 (Outlet)
Shaft No 2
Shaft No 3
Shaft No 4
Shaft No 5
Shaft No 6
Shaft No 7
Shaft No 8 Ware River (Intake)
Muschopauge Pond
Moulton Pond
Potter Pond
Excavation to March 1, 1933

existed on the line between Shafts 1 and 2; and in order to assure an adequate depth of sound rock above the tunnel, the grade was lowered approximately 200 feet more than the requirements of the hydraulic grade indicated.

The location of Shaft 8, the intake of the Ware river diversion, was fixed within certain limits by law, and by natural conditions along the river bank. Shaft 1, the outlet, was limited to a location on the northwest side of the Wachusett reservoir, suitable for possible power developments. Because of the possibility of developing a considerable head between the Quinapoxet river-Trout brook junction and Shaft 1, the location of Shaft 2 was fixed near this former point, where the combined flows of the Quinapoxet river and Trout brook could easily be diverted into the shaft, if found desirable at any future time.

In order to assure the speedy prosecution of the work and have the tunnel excavation completed for water diversion in 1931, eight shafts were located as near equally apart as natural conditions would allow, it being essential for economic constructions to have the total depth of the shafts as shallow as possible with a minimum of earth cover above sound rock. All were successfully located in this regard, except Shaft 3, which was located in an area of rather deep glacial drift, requiring the sinking of an open concrete caisson to rock. The spacing and location of these shafts is shown on the plan and profile. Shafts 2-7 inclusive serve the purpose of construction shafts only, providing fourteen headings for excavating operations. Shaft 1 provides only a west heading, whereas Shaft 8 provides two headings, one heading being projected westerly for a short distance for connection to a possible future extension. Contracts, totalling $650,000, for Shafts 2-7 inclusive, were let during the spring of 1927; and for the tunnel and Shafts 1 and 8 a year later, which totalled approximately $8,800,000. The former contracts included items for the sinking of shafts to tunnel grade and the driving of fifty feet of tunnel either side of the shaft center lines. All shafts are lined with unreinforced concrete masonry.

A 22,000-volt transmission line, running from a transformer sub-station at West Boylston, on the east end of the Wachusett-Coldbrook tunnel, over a 50 ft. right-of-way on the center line of tunnel, to Shaft 8 at the west end, was erected by the New England Power Company. This transmission line, erected on wooden poles from 35 to 45 feet in height, furnishes electrical energy at the shaft power houses. At each of the shafts there was installed a series of transformer banks for stepping the higher voltage down to 440 for power and shooting, and 220 for lighting purposes.

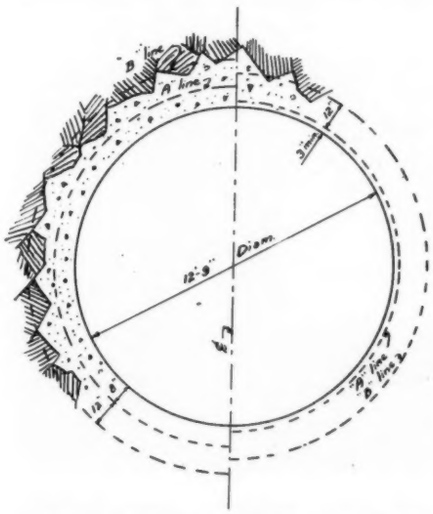
For payment on excavation, certain reference lines are provided, and designated as the "A" and "B" lines. The "A" line is the line within which no unexcavated material of any kind is permitted to remain, and has a minimum distance of 3 inches back of the neat line of concrete. The "B" line delimits all excavation and concrete shaft lining paid for, and is fixed arbitrarily 12 inches in back of the "A" line. The six construction shafts are of circular section with a neat line diameter of 14 feet, and a minimum "B" line diameter of 16½ feet.

Similar reference lines are used for the two tunnel sections, one of which is circular of 12 feet 9 inches inside diameter, and the other of horseshoe shape 11 feet wide and 12 feet 9 inches high, with a cross-sectional area equivalent to that of the circular section. The "A" line is fixed at a minimum distance of 3 inches in back of the neat line on the side walls of the tunnel but 8 inches above the neat line in the arch. The "B" line is arbitrarily placed 12 inches in back of the "A" line. Slight modifications of these distances are made in cases of permanent timbering. All payment for excavation is for that volume bounded by the "B" line, and for concrete that volume between the neat line of concrete and the "B" line.

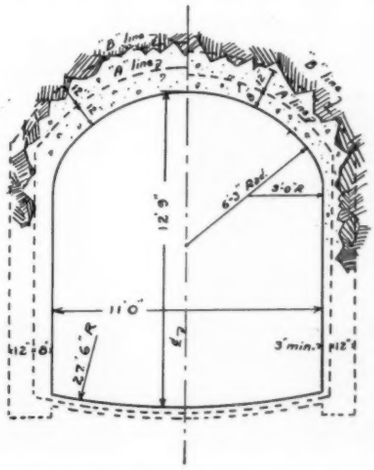
THE WATERWAY SHAFTS

Shaft 1, as completed, will consist of two shafts, one an outlet waterway shaft and the other a pump shaft to provide for the installation of pumping equipment whenever it is required to unwater the tunnel. During construction it was excavated and lined as a single shaft, and later will be provided with a reinforced concrete partition. To insure watertightness, the pump shaft will have a steel interlining. At the shaft head, two horizontal openings will take the water into the outlet channel and thence to the reservoir. One of these openings will provide a future penstock connection, and the other will serve as a blow-off. The retaining walls for the outlet channel have been designed to serve as foundations for a future hydro-electric power station. For the measurement of flow, a vertical Venturi meter of 90-inch throat, cast in the concrete shaft lining, will be provided.

The diversion of the Ware river at Shaft 8 will be accomplished by the construction of several siphon spillways of various capacities, which are designed to insure complete diversion above the prescribed limit of 85 mgd, and prevent any diversion below this limit. The water will be discharged into a chamber at the top of the shaft, and then pass through four



TUNNEL SECTION, CIRCULAR TYPE



TUNNEL SECTION, HORSESHOE TYPE

butterfly valves, from which it will drop approximately 200 feet in a spiral course to the tunnel. A special type of cast iron lining, furnished with lugs or projections aligned in a helical path, will be placed to accomplish this result. The shaft was lined initially with unreinforced concrete masonry, and will be used in that form during excavation and lining of the tunnel, after which the special cast iron lining will be installed. In the chamber, at the head of the shaft, a Venturi meter will be erected over one of the butterfly valves, which will measure the diversion up to the meter capacity of about 800 mgd.

CONSTRUCTION OF SHAFTS AND TUNNEL

Shaft 5, being the deepest of the shafts, was started on April 1, 1927, about two months in advance of the others. Shafts 2, 3, 4, 6 and 7 were all started during the first week in June, 1927. Shafts 1 and 8 were started in June, 1928.

In the excavation of the shafts an average round of forty holes was drilled with Sullivan rotator drills. The cut holes were loaded with 60% dynamite and the remainder with 40%, and detonated by instantaneous and delay exploders.

The muck was shovelled by hand into buckets and lifted out of the shaft by means of an electrically driven single-drum hoist located about 100 feet from the head-frame.

The earth sections in all shafts were timbered, octagonal sets of 8-inch by 8-inch timbers and 2-inch lagging being installed. The earth covering the ledge varied in depths from 19 feet to 61 feet.

For placing the concrete lining, wooden forms were used, made up of four sections to the circle, 5 feet high. The mixing plant was located close to the collar of the shaft, making it possible to feed directly into concrete buckets suspended on the main fall. These buckets were lowered and the concrete discharged into a chute over the form.

When about 60 or 70 feet of shaft had been excavated, this depth was concreted before excavation was resumed. The lowest form was supported on a bulkhead resting on the bottom of the excavation.

The mix used was 1:2:4, without steel reinforcing.

The average weekly progress for shaft excavation and concrete lining was 19 feet. All work in connection with the sinking and lining of Shafts 2, 3, 4, 5, 6 and 7 was completed by the end of the year 1927. By the middle of January, 1928, headings were turned both east and west from each of the shafts. Contracts 4 and 8 required the excavation of 50 feet of tunnel on each side of shaft center line.

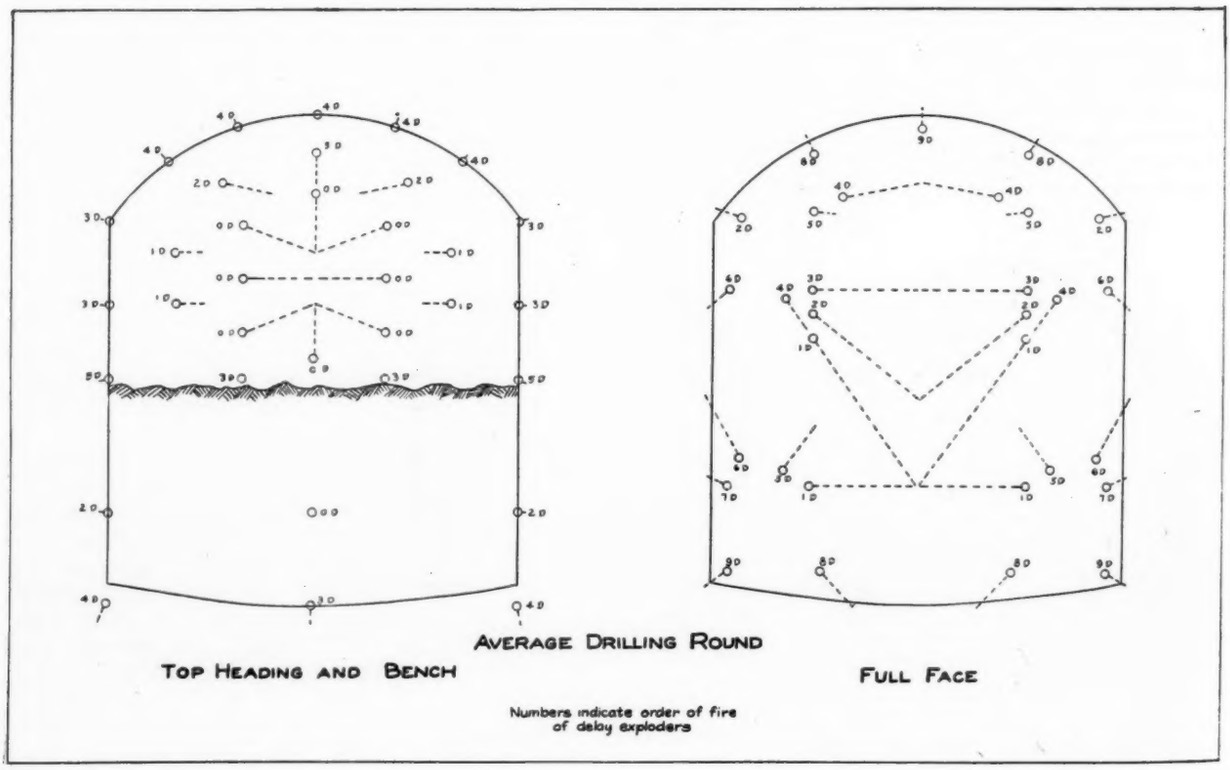
Contracts 14 and 17 cover the excavation and lining of 13 miles of tunnel and the excavation and lining of Shaft 8 (the inlet shaft) and of Shaft 1 (the outlet shaft). These contracts were awarded to J. P. Porter & Sons of Oregon, and Coughlan & Porter of Boston, who in turn assigned the contracts to the West Construction Co.

In May, 1928, preparations were made for dismantling the plant and equipment which had been used in sinking the shafts and replacing this with new plant adapted to driving tunnel.

The camps were remodelled and enlarged and facilities added to accommodate the increase in the number of employees.

Each camp now has, besides the sleeping quarters and a mess hall, a power house, blacksmith shop, machine shop, store-house, powder magazine, dry house, blower house, and contractor's and engineers' office. A first-aid room, well furnished with modern equipment, is available for emergencies.

For distributing the excavated material over the area allotted for spoil bank, timber trestles were built



SETTLING BASIN AND FILTERS AT SHAFT NO. 2, LOOKING EAST FROM SPOIL PILE. CHLORINATING HOUSE IN CENTER BACKGROUND. POWDER MAGAZINE AT RIGHT

CAMP BUILDINGS AT SHAFT NO. 2, LOOKING SOUTH FROM SPOIL BANK AT SHAFT.

extending from timber headframes 50 feet in height.

Each shaft is provided with two balanced, non-self-dumping cages, 8 feet by 5 feet, equipped with safety catches, automatic car stops and landing dogs. These cages are operated by electrically driven single-drum mine hoists with a 1-inch stranded wire rope fall.

Power for operating the air-driven loaders, the drills, pumps and drill sharpeners is furnished by Sullivan angle-compound air compressors.

Powder smoke and foul air is removed from the tunnel by means of a Connersville 16-inch by 40-inch blower rated at 4000 cu. ft. of free air per minute. The blower is set up a short distance from the collar of the shaft and is connected to a 14-inch galvanized sheet metal stack in the shaft which acts as the uptake. The shaft itself is the downtake in this ventilating system. At some of the shafts the metal ventilating pipe continues into the headings from a tee at the bottom of the stack, while at others fir pipe is used.

Two different methods of driving tunnel are employed; one, the full face method, as at Shafts 2 and 4; and the other, the top heading and bench method, as at Shafts 5, 6, 7 and 8. These will be gone into in detail subsequently.

Other methods were tried, found wanting and ultimately abandoned. For example, at Shaft 6 the top bench and bottom heading method (sometimes called the "breakdown") was experimented with for about 500 feet of tunnel. A round of holes was drilled in the bottom to take out a section 7 feet high and 11 feet wide, leaving the arched section of the horseshoe about 5 feet high in the center. After the bottom heading had been advanced far enough ahead, timber sets with heavy plank lagging were erected under the arch section. The rock remaining in this section was then shot down on to these timbers, muck cars were run under the section, and the muck loaded directly into cars by removing the loose planking. It was found that this method was not economical for a tunnel of this size, although it might work out favorably for a larger tunnel.

Excavation by manual labor was resorted to in several of the headings. When mucking by hand, ¼-inch steel "slick sheets" were laid down on the invert, close to the bench, making a smooth surface for the shovels.

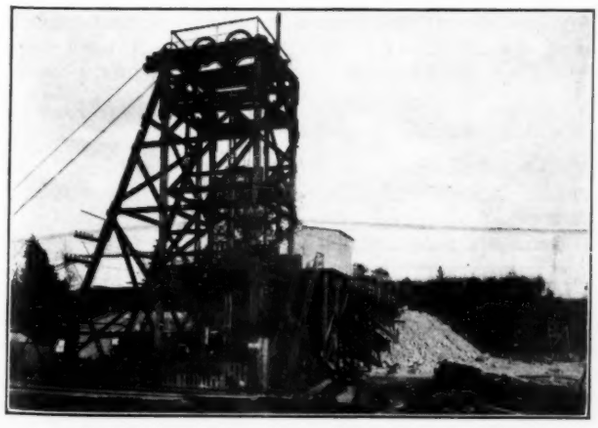
After the round had been shot, a wooden plank scaffold about 20 feet long was run out over the top of the bench. One end of this scaffold rested on the bench and the other was supported by two lengths of 3-inch pipe extending across the tunnel and held in place by short lengths of drill steel inserted in holes in the tunnel walls.

A bench approximately 25 feet in length was maintained, affording ample room for laborers on top of the bench without interfering with the drilling crew. At the same time the remainder of the mucking crew could shovel directly into the cars from the muck pile on the "slick sheet."

Various types of mechanical loaders have displaced hand methods; Conway mucking machines, motor-driven; Hoar air-driven mucking machines and Butler underground shovels, also air-driven.

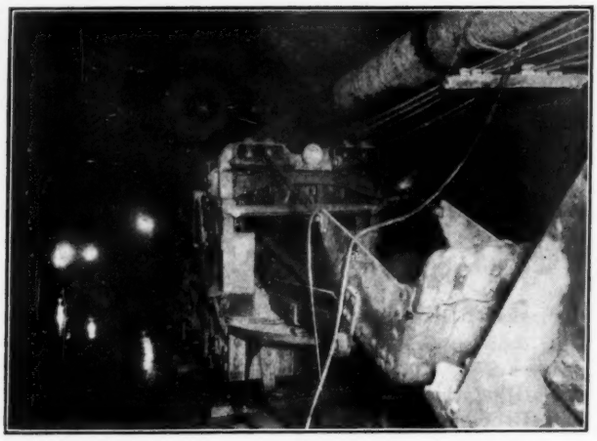
FULL-FACE METHOD OF TUNNEL DRIVING

Drilling.—A drill carriage of special design, carrying all the necessary drilling equipment, is moved by a motor up to the face of the tunnel. This carriage consists of a wood and steel frame mounted on a chassis of a discarded steel muck car. Air and water lines are provided, with manifolds and automatic oilers on the front end, and tees with rubber hose connections to main pipe lines on the rear of the carriage. Each of these frames carries a full round of drill steel



HEAD-FRAME, TRESTLE AND BEGINNING OF SPOIL PILE AT SHAFT NO. 4, LOOKING EASTERLY ALONG TUNNEL LINE.

TUNNEL AT FOOT OF SHAFT NO. 2, LOOKING EAST SHOWING TRACK SYSTEM, VENTILATING AND OTHER PIPES, WIRING, ETC.



CONWAY MUCKING MACHINE ON TURNTABLE
East heading of shaft No. 2, looking east.

besides five water drifters, drilling bars, chuck wrenches, blocking and wedges, etc.

From the front of the frame are suspended two 3-inch bars 11½ feet long, with extension arms and universal joints. When the carriage is in place, these bars are raised into position by means of a steel cable operated by a hand winch, the cable being threaded over a sheave on an "A" frame made up of steel channels.

When the two bars have been fixed in their proper position, as shown on the accompanying sketch, they are blocked and wedged and made fast by tightening up a screw-jack on one end of the bar. The drills are then aligned and tightened.

In an eight-hour shift, with this drilling arrangement and a mechanical loader, a crew can average one full round, drilled, loaded and shot, and have time to set up and start another, including the time required to move from one heading to another. Each round consists of 31 holes with some necessary variations.

Although the rock is fairly hard and tough, it breaks easily with 40% and 60% gelatin dynamite. Instantaneous and delay exploders are connected in parallel to two No. 20 bare copper wire bus bars suspended on short poles. A few loops of the bus wire are wrapped around the poles with enough left over to connect to the main, No. 10 copper wire, firing line. All firing is done with 440-volt A. C. current through a safety switch located in the station at the bottom of the shaft.

Mucking.—As soon as convenient after the shot, the Conway mucking machine moves toward the heading, cleaning up fly-rock as it approaches the muck pile. A steel muck car of 3 cu. yd. capacity follows and, when filled, is drawn back behind an air lift, by means of which another empty car is placed on the main track, then pushed up to the mucking machine. This air lift is maintained about 200 feet back from the breast of the tunnel. This operation is repeated until three cars have been filled, then these are hauled to the shaft by an electric storage battery locomotive while another locomotive hauls a train of empty cars to the air lift.

Muck is hauled from the shaft to the spoil bank by a Plymouth gasoline locomotive.

THE TOP HEADING AND BENCH METHOD

Drilling.—This method was adopted from the beginning at Shafts 5, 6, 7 and 8, where it is still being used.

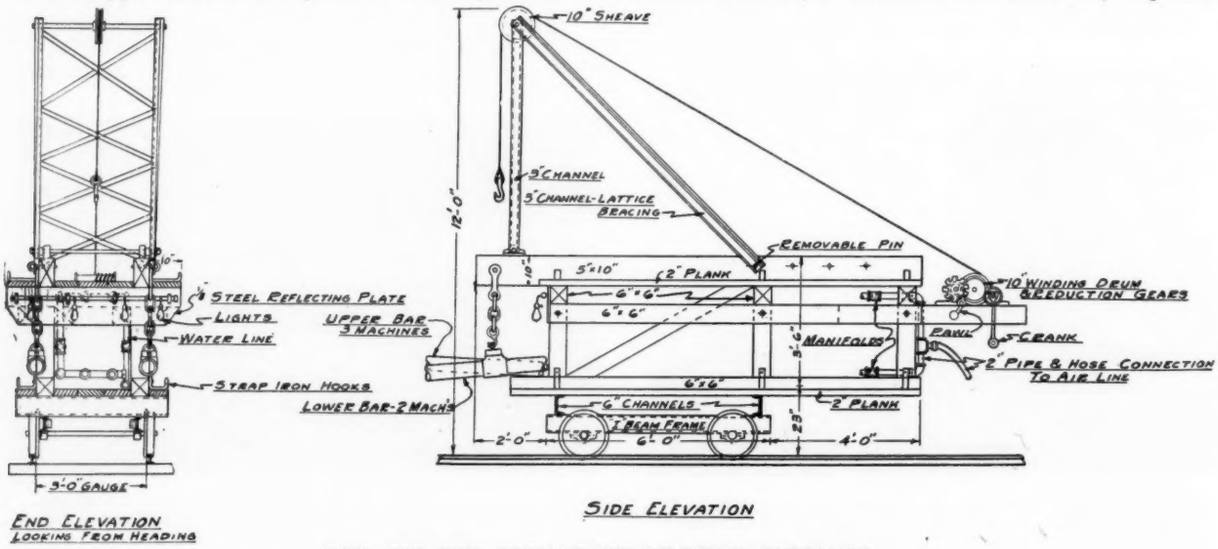
After a round has been shot, the drilling crew enters the heading and mucks back from the face for about 3 feet to provide space for setting up the drilling equipment. Two vertical drilling columns are then set up about 6 feet apart and 2½ or 3 feet away from the face. These columns are equipped with extension arms, universal joints and saddles for the accommodation of three Sullivan water drifters.

Air and water lines are run up the tunnel to within 50 feet of the headings, where they are coupled to manifolds. Each manifold has 4 or 5 valves, and connections for a 50-foot hose to each drill.

After the heading has been drilled and the front of the bench cleared of muck, a horizontal bar about 11½ feet long and 3 inches in diameter is set up about 18 inches above the invert. Two water drifters are mounted on this bar to drill the bench holes.

With the heading and bench, a total of 34 holes are drilled, six of these being in the bench.

The cut holes in the heading are loaded with 60% gelatin dynamite and the remainder, including the bench, with 40%. Instantaneous and delay exploders



SIDE AND END ELEVATIONS OF DRILL CARRIAGE

are used and these are connected up in series both in heading and bench.

Mucking.—A short bench, seldom over 10 feet long, is maintained in order that the material from the heading will fall over the bench where it can be reached readily by the mucking machine.

Empty muck cars are stored on a turnout from the main line within 200 feet of the mucker. At Shafts 5, 6 and 7 at the present time, mules haul the loaded cars (1 2/3 cu. yd. steel side-dump) from the mucker up to the turnout, bringing back an empty car to the heading. Another mule hauls loaded cars from the turnout to the shaft where they are loaded on the cages. On the return trip this mule brings back a train of empty cars to the turnout and this operation is repeated.

The contractor's force at Shafts 2 and 4 are working three eight-hour shifts, while those at Shafts 5, 6, 7 and 8 are working two ten-hour shifts. Each of these schedules is favorably adapted to the methods of excavation employed.

The circular section of tunnel, west of Shaft 1, is being driven as a top heading, leaving a bench 5 feet high in place, which will be removed as continuous bench excavation, after the prescribed length of heading of circular section has been driven. The total length of circular tunnel is to be fixed arbitrarily by the engineer.

All water encountered in the tunnel, together with the waste water from the drilling machines, is pumped or drained into a sump at the bottom of the shaft and thence pumped to the top of the shaft, discharging through a 6-inch steel pipe. To date, water has not been a serious handicap in any of the headings, although it has been necessary, at some of the shafts, to increase the original pumping capacity. The maximum amount pumped at any one shaft has not exceeded 500 gallons per minute.

Provision is made for chemical treatment of water pumped from the shafts located on the watershed of the present Wachusett reservoir.

A bill passed by the Massachusetts Legislature in 1926 established a special Metropolitan District Water Supply Commission of three members to carry out the provisions of the Water Acts. The present members of the Commission are Davis B. Kenniston, chairman, Charles M. Davenport and Joseph H. Soliday.

Direct supervision of the project is in charge of Frank E. Winsor, chief engineer, Karl R. Kennison, designing engineer, and William W. Peabody and Richard R. Bradbury, division engineers. J. Waldo Smith and X. H. Goodnough are consulting engineers.

Mamaroneck Sewer Outfall

The Westchester County Sanitary Sewer Commission has awarded a contract to the Merritt-Chapman & Scott Corporation and work has already commenced on a project known as the Mamaroneck sewer outfall, the contract price being $780,970. The work consists of a submarine pipe line 12,000 feet in length, of 54-inch bell and spigot cast-iron pipe. The line will extend from the pumping station at Mamaroneck harbor, up through the harbor and out into Long Island sound.

The pipe, in sections of four to six lengths of 12 feet each, is to be laid by large floating derricks, in a trench previously excavated by dredges. The joints between sections are to be made under water by divers and the pipe trench is to be backfilled by dredges. The specifications call for a very rigid pressure test before acceptance. It is estimated that the work will require about eight months time. It is to be done under the supervision of the Westchester County Sanitary Sewer Commission, of which W. W. Young is consulting engineer.

Besides the Merritt-Chapman & Scott Corporation's bid of $780,790, the following tenders were received: Bay State Dredging & Contracting Co., $1,233,000; Montrose Contracting Co., $1,156,750; Frederick Snare Corporation, $1,099,800.

New York's New Distribution Tunnel

Only a few years ago New York City finished constructing a tunnel through rock far below the surface of its streets for distributing throughout the city water from the Catskill watershed. Already the capacity of this tunnel has been nearly reached and in fact is not sufficient to maintain suitable pressure in the boroughs of Brooklyn and Queens. Consequently it is necessary to supply increased capacity to the distribution system and with this in view, work is being begun on a new distribution tunnel which will be 20.2 miles long and will be excavated in solid rock, 19 feet in diameter with an average of 1-foot lining of concrete, giving a finished diameter of 17 feet. This tunnel will be located at a depth of about 500 feet below sea level, which will bring it from 500 to 850 feet below the ground surface. This tunnel will run from Hill View reservoir, east through Bronx borough, then under the East River and south to Brooklyn, where it will end at Hamilton avenue, opposite Governor's Island.

In constructing this tunnel, sixteen shafts will be sunk from 14 to 22 feet in diameter, which will be used for construction but will be retained to serve as risers to valve chambers from which the street mains will be supplied. The construction of this tunnel will involve removing about four million cubic yards of rock and the lining will require about 664,000 cubic yards of concrete. Contract for constructing the tunnel has been let to Patrick McGovern, Inc., by the Board of Water Supply.

In the construction of the tunnel, electricity will be used largely. Air for drills and shovels will be furnished by 400-horsepower synchronous motor-driven compressors. The muck will be removed through the tunnel to the nearest shaft by storage battery mine locomotives, and at the shaft will be raised to the surface in cages, of which each shaft will contain two in balance, one coming up as the other goes down. The cages will be rectangular in shape, while the shaft is to be cylindrical; the remaining space being used for water pipes, air pipes, electric cables, etc. A 30-ton hoist will lift the cages, using 1¼-inch hoisting ropes on drums approximately seven feet in diameter and making twenty-two revolutions a minute. Each hoist will be driven by a 250 h. p. General Electric Motor, with variable generator voltage control.

The hauling will be done by sixty-two 7-ton storage battery locomotives which are now being built by the General Electric Company and correspond in type to those used in the construction of the Cascade, Moffet, Hetch-Hetchy, Shandaken, and the Cold

Brook-Wachusett tunnels. Each locomotive will be driven by two 12-h. p. motors, power for which will be furnished by a storage battery consisting of 42 Exide cells. When the batteries have been discharged, the locomotives will be hoisted to the surface for recharging the batteries. Electric power for the project will be purchased from six public service companies, the various voltages being stepped down to operating values by suitable transformers, except where the larger motors can be operated suitably with the higher voltages.

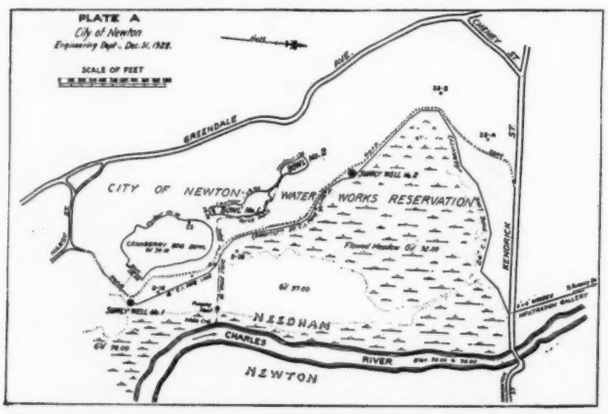
Developing Ground Water Supply at Newton.

Supply obtained from shallow wells increased by pumping river water into basins on collection area.

Newton, Massachusetts, with an estimated population of 58,000, for its water supply uses ground water obtained from underground collecting conduits and shallow wells located in a reservation at Needham. The water consumption in 1928 averaged 77½ gallons per capita per day.

During 1928 the question of an additional water supply was studied by a special committee on water composed of three aldermen, with Ernest H. Harvey, designing engineer from the city engineer's office in charge of the work; while meetings of the committee were attended by Geo. A. Sampson, of the firm of Weston & Sampson, consulting engineers on water supply for the city, water commissioner J. C. Whitney, pumping engineer Mark V. Croker, and city engineer William P. Morse. It was decided to conduct an experiment in the water works land in Needham, on the westerly side of the Charles river, to determine whether or not it would be practicable to increase the yield of ground water in this territory by flooding certain natural bowls or basins in the higher land towards the west with water pumped from the Charles river. It was from these lands that the city already obtained its supply through two large concrete supply wells and several tube wells. The general location of these and the elevation of the ground and of the Charles river are shown on the accompanying map.

By pumping water from the river onto the higher land, it was thought that this water would filter through the underlying sand and gravel and a large



MAP OF NEWTON S WATER WORKS RESERVATION

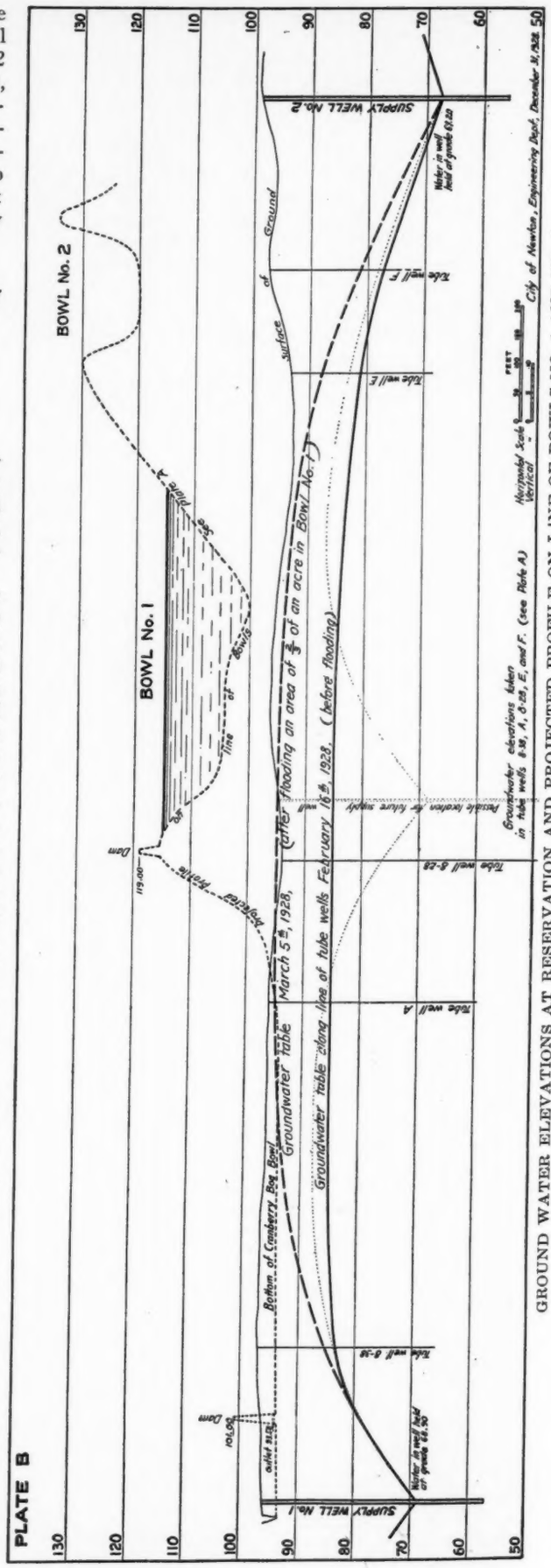


PLATE B
BOWL No. 2
BOWL No. 1
SUPPLY WELL No. 2
SUPPLY WELL No. 1
Ground surface
Tube well E
Tube well 8-28
Tube well A
Tube well 8-38
Dam
Pipe
Weir
Bottom of Cranberry Bog
Groundwater table
March 5th, 1928.
Groundwater table along line of tube wells February 16th, 1928. (before flooding)
after flooding an area of ¾ of an acre in Bowl No. 1
Water in well held at grade 61.20
Water at pool elev. 62.50
Horizontal Scale 1" = 100 FEET
Vertical 1" = 5 FEET
City of Newton, Engineering Dept. December 31, 1928

GROUND WATER ELEVATIONS AT RESERVATION AND PROJECTED PROFILE ON LINE OF BOWLS NO. 1 AND NO. 2

part of it could be recovered from these wells. It was thought probable, also, that the hard ground water would be somewhat tempered to advantage by an admixture of the softer surface water. At an elevation somewhat higher than the wells there are several natural bowls, far enough from the wells to insure sufficient filtration of the water, and it was decided to pump the river water into one or more of these, first removing the top soil of loam and other surface materials. It was thought probable that exposure of the water to the air and sunlight while standing in these bowls would in a measure help in the purification process; and that millions of gallons, finding storage in the ground, would augment the supply in dry seasons.

A bowl called on the map Bowl No. 1, located 1200 feet back from the river and at elevation 100 at its lowest point, was selected for the experiment and the loam was removed from it to a depth of from 2 to 5 feet over an area 40 feet wide and 700 feet long, making about two-thirds of an acre. Five thousand yards of this overburden was removed at a contract price of $1000.

Meantime the water department built a pump well at the river and installed pumping equipment owned by the department consisting of a 20-h.p. motor direct connected to an 8-inch centrifugal pump capable of pumping about 1,400,000 gallons per day against a head of about 50 feet. A discharge line of 12-inch wood-stave pipe about 950 feet long was laid from this pump to the bowl at a cost of about $2.00 per foot for pipe and laying.

On February 16 continuous pumping was started from the river to the bowl and careful observations were taken thereafter on the daily output of the two supply wells and at numerous tube wells over the whole territory in order to show the effect of the flooding of the bowl on the ground water level. Also samples of the water for analysis were taken at frequent intervals for the city at various wells by Mr. Sampson and by the Massachusetts Department of Public Health; and the analyses showed in every case an extremely high quality of water.

The output from the two large concrete supply wells was determined by careful observation over a period just prior to the experiment as being about 800,000 gallons and 1,160,000 per day respectively. On February 18, after two days of flooding, the ground water had started to rise in the tube wells and an increase had occurred in the output of the two supply wells, the elevation of water in these wells being maintained constant throughout the experiment. After ten days of flooding, the increase in well number 1 was about 230,000 gallons per day and that in well number 2 was about 550,000 gallons per day, or an increase in volume of water collected in this territory of about 40%. Of the 1,400,000 gallons per day pumped into the bowl from the river, about 780,000 gallons were recovered at the two wells, or about 56%. During the experiment, the Charles river varied about two feet in elevation and this change produced a very noticeable effect on the extra quantity of water obtained from the wells, the quantity increasing as the elevation of the river increased.

After the success of the flooding proposition seemed to have been demonstrated, it was thought advisable to continue flooding operations, and in July a contract was let to finish excavating bowl number 1 and to excavate the surface material from another smaller bowl to the north of and adjacent to bowl number 1 to be called bowl number 2. This work, which involved excavating about 14,500 cubic yards at a cost of $9,500, was completed last fall.

This gave a capacity of bowl number 1, if filled to grade 119, of about 6,000,000 gallons, while the water covered an area of about 1.8 acres. The capacity of bowl number 2, if filled to grade 130, is about 1,500,000 gallons and the water covers an area of about 0.65 acre. At the end of 1928, when this report was written by William P. Morse, the city engineer, (from whose report this description is taken), a concrete intake crib was under construction in the river, connected by a 24-inch vitrified pipe line to the pump well of the flooding plant. This pump well had been built of concrete on hard land about 150 feet back from the river, and a new pumping equipment installed consisting of a 50-horsepower motor direct connected to a 10-inch centrifugal pump capable of delivering 3,500,000 gallons per day against a total pumping head of 60 feet, and the 12-inch wood-stave pipe discharge line from this pump was extended on up to bowl number 2 with a total length of about 1730 feet.

From plate B, showing the ground water elevations, it appears that about half way between the two present supply wells lies a section which would bear investigation with a view to the construction of another supply well. It was at this point that the greater part of that water from the flooded bowl not recovered at the wells came to the surface of the ground and flowed off over the flooded meadow. During the flooding of the bowl, water flowed continuously from the pipe of tube well 8-28 at an elevation 1.5 feet above the ground.

Leakage of Ground Water Into Sewers

By Samuel T. Drew*

The leakage or infiltration of ground water into some new sewers constructed last summer in Concord, Mass., was determined during the period from April 5 to 11, 1929.

The soil in which the sewers were built is chiefly coarse, open sand. The sewers were of 6, 8, 10 and 12-in. diameter and the house connections of 5-in. diameter. Vitrified clay pipe was used, with plastic joints.

The leakage was computed from the capacity of the suction well and the time of filling same.

Of the 5.18 miles of sewer tributary to the pumping station at which the leakage was measured, about 2.22 miles of sewers were contributing no leakage at the time of the inspection. This probably indicates that these sewers lay above the elevation of the ground water table at that particular time. The remaining 2.96 miles contributed leakage to the extent of about 6,800 gallons per day per mile. If spread over the entire 5.18 miles, the leakage would be cut down to 3,900 gallons per day per mile.

During the period in which the measurements were made, rain fell on four days and the ground-water

*With Metcalf & Eddy, Boston, Mass.

table undoubtedly was high. At this time only 16 house connections had been made and about half of these were in service. Undoubtedly the amount of leakage will increase as additional house connections are made, although many of the house connections in this vicinity probably will lie above the ground-water table and contribute no leakage.

The leakage into the old sewer system at Concord was given as 30,000 gallons per day per mile in the report of the Sewer Commissioners for 1900.

A comparison of measurements in other cities indicates that this rate of leakage is low. For example, figures given in a table in the second edition of Volume I of "American Sewerage Practice," prepared from data compiled from answers to a questionnaire by "Public Works" in 1927, indicate that a leakage of 25,000 to 50,000 gallons per day per mile is not an unusual amount to expect.

Supplying Water by Steamer

The island of Aruba, off the coast of Venezuela and part of the Dutch colony of Curacao, with an area of 69 square miles and a population of about 7,000, recently obtained a supply of potable water from Baltimore, Md., its local supply being nearly exhausted. During April the tanker Franklin K. Lane (oil is practically the sole export of the island) left Baltimore for the island carrying 25,000 barrels of water. This is the first time such a cargo has been sent from Baltimore.

Developing a Surface Water Supply

Effect on future quantity requirements of changes in industrial conditions and standards of living, of metering and water rates, paving and water pressure. Fluctuations in precipitation and run-off, and allowance for maximum and minimum conditions.

By Arthur L. Reeder*, M. Am. Soc. C. E.; M. Am. W. W. A.

The development of a satisfactory public water supply is not a matter which can safely be left to chance. Even in those cases requiring but 200,000 to 300,000 gallons per day, expensive mistakes can frequently be avoided by expert study and design; except, possibly, where but one source is available, the dry weather flow is ample for all needs, pumping is unnecessary and the quality is such that no preparation of the water is required. Let us briefly examine the various stages of the work in the more complicated cases.

QUANTITY REQUIREMENTS

Studies should be made to determine as closely as may be the present and future demands, taking into consideration not only probable increases in population within the district presently to be served and the possibilities of growth from the extension of the limits of that district, but also those changes in industrial conditions and in standards of living which may affect the per capita consumption.

The rate of growth in population can best be estimated by a competent outside authority of sufficiently wide experience, free from local prejudices but working in cooperation with local people who are thoroughly familiar with the characteristics of the community and its people, the history of the municipality, present and prospective industries, and local conditions likely to attract or repel new industries. Those too intimately associated with local development are frequently subject to extremes of optimism—leading to over-development, or of pessimism—leading to a hampering of future growth through failure to provide an adequate water supply. One with a broader viewpoint can often avoid both errors by making a wise comparison of local conditions with those obtaining elsewhere.

One composite method of comparison frequently used is that of investigating the growth of other comparable communities after their population has passed that of the community in question. This method does not always furnish a fair criterion, as many factors of uncertainty are present and the trick is in finding truly "comparable" communities. At best, in order to secure the data necessary to forecast the growth for twenty or thirty years, the comparison must be made with the growth of other communities during a period twenty or thirty years earlier, and frequently that growth has taken place under social and economic conditions which have changed completely. At times unfortunate comparisons are made, as in the case of a certain inland city where comparison was made with the rate of growth of New York City eighty years before—during the days before the telegraph, telephone, typewriter, electric lights and power, steamships, railroads, subways, automobiles, and aeroplanes were developed. Data can usually be found by proper selection to support any assumption within reason, but the most probable answer to the problem can be obtained only by the exercise of trained and enlightened judgment, guided by "common sense," reviewing all ascertainable facts.

Changes in the per capita consumption may result from changes in the domestic, public, commercial or industrial consumption. Full metering, coupled with high charges for water, will tend to reduce the per capita domestic consumption, as will a radical change in the type of population, such as that caused by a large influx of foreigners from countries where the standards of water consumption are low, or even a material addition of workers from surrounding farming communities. Marked reduction is not to be looked for from universal metering where the water rates are too low to furnish an incentive for reduction. Widespread prosperity, low water rates, extension of

*Principal Assistant Engineer, with H. Burdett Cleveland, consulting sanitary engineer, New York City.

sanitary conveniences, etc., will tend to increase the per capita consumption for domestic purposes.

Improved paving, public bath houses and swimming pools, increased water pressures, increased fire hazards and many other influences tend to increase the public use of water. Improved paving not only calls for the use of more water for street cleaning, but in many places tends to discourage adequate maintenance of underground structures, leading to an increase in "unaccounted for" water.

Commercial and industrial uses will be affected by the number and kind of industries attracted to the community—some industries being very heavy water users—as well as whether private sources of satisfactory supply can be developed at a cost to compete with the public supply. The matter of new industries is determined not only by natural advantages, shipping facilities and labor conditions, but by the viewpoint of the rank and file of the community and of their leaders. Some communities, for well-defined and legitimate reasons, discourage the establishment of new industries, preferring to retain their residential character, while others conduct an aggressive campaign to attract new business, sometimes to take up the slack of seasonal employment in established industries.

As a case in point, it is said that some years ago Henry Ford considered establishing an automobile factory in a certain eastern city, but found the Chamber of Commerce and the City Fathers so unresponsive that he dropped the project. As a result, the population increased twelve per cent during the last decade, whereas a different attitude on the part of the city would have assured not less than one hundred per cent growth. This is not mentioned as a criticism of the city's attitude toward new business—perhaps the people are happier than they would have been if a large influx of new labor had taken place—but it shows one difficulty of gaging future water demands.

The accompanying chart shows the classification of water consumption in Reading, Penna., for the year 1920, and is more or less typical for an industrial community at a time when a considerable percentage of domestic taps were unmetered, water rates were low (4 cents per 100 cubic feet), a large part of the city was not sewered, and revenue was insufficient for proper maintenance of transmission mains and distribution system. Industries were very largely dependent on the public supply, as local ground waters were too hard for use. At that time, the average daily consumption for all purposes amounted to 16.42 million gallons, or a per capita consumption of 154.5 gallons daily.

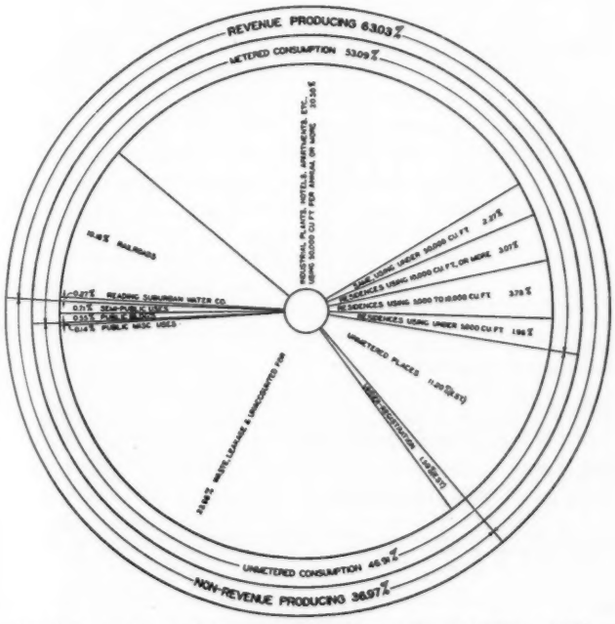

REVENUE PRODUCING 63.03%
METERED CONSUMPTION 53.09%
INDUSTRIAL PLANTS, HOTELS, APARTMENTS, ETC., USING 50,000 CU FT PER ANNUAL OR MORE 20.36%
RAILROADS 11.6%
READING SUBURBAN WATER CO. 4.02%
SCHOOLS 0.31%
PUBLIC BLDGS. 0.10%
PUBLIC MISC. USES 0.24%
RESIDENCES USING 50,000 CU FT OR MORE 2.27%
RESIDENCES USING 10,000 CU FT. OR MORE 3.07%
RESIDENCES USING 5000 TO 10,000 CU FT 3.78%
RESIDENCES USING UNDER 5000 CU FT 19.8%
UNMETERED PLACES 11.06%
METER REGISTRATION 1.68%
WASTE, LEAKAGE & UNACCOUNTED FOR 34.94%
UNMETERED CONSUMPTION 46.94%
NON-REVENUE PRODUCING 36.97%

CHART NO. 1—CLASSIFICATION OF WATER CONSUMPTION, CALENDAR YEAR 1920.

While investigating average demand, an attempt should be made to determine the monthly, weekly, daily and hourly rates of consumption, as these figures will be needed in fixing the capacities of reservoirs, pumps, pipe lines and filter plant.

SELECTING SOURCE OF SUPPLY

Having established the present consumption, the number of years the proposed plant should take care of without major extensions, and the probable increase in demand during that period, there yet remains the question of a suitable source of supply. No feasible source of sufficient capacity should be dismissed without proper consideration. It may be of interest to note that some fifty years ago the city of Philadelphia seriously considered going to Lake Erie for its entire water supply, and in more recent years has considered the upper waters of the Lehigh and Delaware rivers, as well as the lower waters of the Susquehanna river. All these projects were abandoned for the time being, as nearer sources can be developed at less expense to take care of present needs. Under the urge of necessity, most unpromising arrangements have worked out satisfactorily, as in the case of a town whose entire supply of 50,000 gallons daily was shipped in in tank cars, or a certain island which found it necessary to meet seasonal excess demands by importing the required amount by steamer from a point 750 miles away. In some cases, two or more sources must be combined to secure the necessary quantity; in others, a similar combination may be desirable in order to reduce or eliminate pumping.

For the purposes of this discussion it is assumed that one or more surface sources have been found which will be suitable, after treatment if necessary. Sometimes several streams are equally satisfactory from a sanitary viewpoint and each would furnish sufficient water to meet the demand for some years to come. A certain town in Pennsylvania is located near the top of a hill, from which four streams lead in as many directions. Each was of sufficient volume, and all were equally subject to contamination. No other source of supply was economically feasible. The private water company was unable to adopt measures to prevent contamination of the raw water supply. The cost of treatment being the same, the choice resolved itself into an economic question of length, size and profile of the required force main, availability of a suitable dam site, cost of developing an impounding dam and reservoir, cost of pumping, etc. Sufficient difference in the costs of construction and operation was disclosed by the investigation to clearly indicate one of these four streams for immediate development.

In studying any prospective source of supply,

whether of surface water or ground water, variations in the rate of flow must be carefully considered, as the cost of impounding sufficient water to tide over periods of low flow is frequently a determining factor. There is an old saying, which has gained widespread acceptance in certain quarters on account of its falsity, that a stream is good for one million gallons daily for each square mile of drainage area. The falsity of this statement is obvious as applying to certain sections of the United States where the annual precipitation is small, as it would necessitate a runoff greater than the total precipitation, because an average flow of one million gallons daily requires a yearly run-off of 21 inches.

Among the factors which affect run-off, one of the most potent is, of course, the precipitation, which varies widely from one locality to another, from year to year and from day to day. Chart No. 2 shows the total yearly precipitation at Reading, Penna., based on daily records covering a period of 46 years. It shows not only the fluctuations in yearly precipitation, but by striking averages the extremes can be eased off and a definite downward trend is noted. It is a matter of general knowledge, based on long-term records from a number of localities, that precipitation varies not only from year to year but also in longer cycles having a period of many years, perhaps a century or more. In the chart shown, it will be noted that the "Normal Yearly Precipitation" has decreased a little more than 5 inches in 46 years. The chart further indicates certain wet and dry spells covering 12 consecutive months, which do not always coincide with the calendar years. Long-term averages of either precipitation or run-off must not be too seriously regarded in determining the reliable yield of a source of supply, for it is impracticable at a reasonable expense to store the flood flows and so equalize the yield over long periods.

Generally speaking, there are certain factors tending to make the fluctuations in run-off less pronounced than those in the precipitation, but at times the melting of snow and ice by mild weather or warm rains may produce a run-off factor of more than 100 per cent. Factors which affect the rate of run-off are evaporation, transpiration, ground water storage conditions, surface slopes and distances from the gaging station, intensity, duration, extent, location and direction of storms, and many others too numerous to mention. Extreme floods and extreme droughts are the results of simultaneous maxima or minima of a large number of conspiring factors, and it is probably safe to say regarding any locality that at no time during recorded history has the greatest possible flood or the greatest possible drought been realized.

For 29 years the city of Philadelphia kept daily records of stream gagings of the Perkiomen, Neshaminy and Tohickon creeks, all within 45 miles of Philadelphia. The accompanying table shows the average yield per square mile for each stream by months. Daily fluctations were, of course, much greater, the flow of Perkiomen creek having fallen as low as 0.031 second-foot per square mile.

Studies were made on the flow of Maiden creek in connection with recent additions to the water supply of Reading, Penna. This stream is a tributary of the Schuylkill river, and above the site of the new dam has a drainage area of 192 square miles, and as approximately 22 per cent of this is in limestone

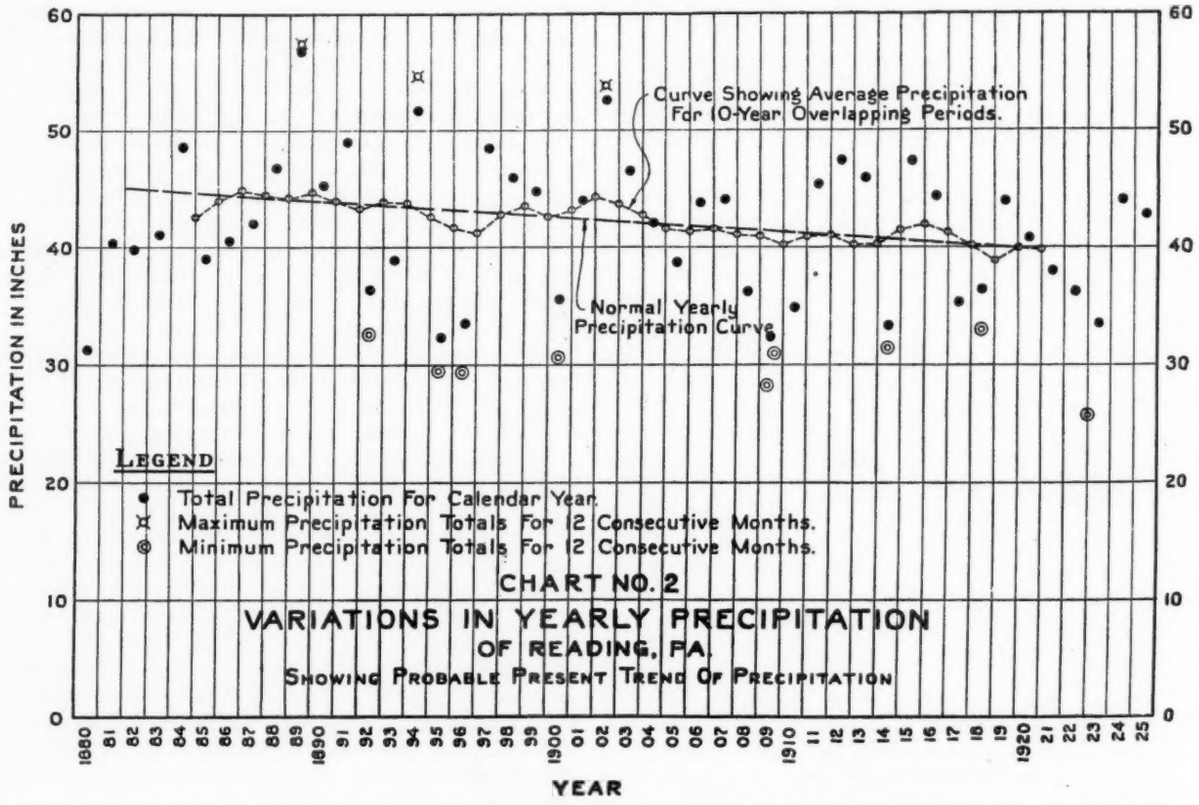

Curve Showing Average Precipitation For 10-Year Overlapping Periods.
Normal Yearly Precipitation Curve
LEGEND
Total Precipitation For Calendar Year.
Maximum Precipitation Totals For 12 Consecutive Months.
Minimum Precipitation Totals For 12 Consecutive Months.
CHART NO. 2
VARIATIONS IN YEARLY PRECIPITATION
OF READING, PA.
SHOWING PROBABLE PRESENT TREND OF PRECIPITATION
PRECIPITATION IN INCHES
YEAR
0
10
20
30
40
50
60
1880 81 82 83 84 85 86 87 88 89 1890 91 92 93 94 95 96 97 98 99 1900 01 02 03 04 05 06 07 08 09 1910 11 12 13 14 15 16 17 18 19 1920 21 22 23 24 25

CHART NO. 2—VARIATIONS IN YEARLY PRECIPITATION DURING 46 YEARS AT READING, PA., SHOWING PROBABLE PRESENT TREND OF PRECIPITATION.

Yield of the Perkiomen, Neshaminy and Tohickon Creeks

Cubic Feet per Second per Square Mile

Average for 29 years—1884—1912

STREAM		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
Perkiomen, at	Max.....	4.5980	5.3850	5.7728	3.4626	5.6800	2.3760	4.2080	2.1450	3.6332	2.4475	6.0540	5.5920	——
Frederick;	Mean.....	2.3785	2.9962	3.3282	1.9109	1.4899	0.8207	0.7999	0.8440	1.0257	0.9529	1.4329	1.8812	——1.6553
152.0 Sq. Mi.	Min.....	0.5150	0.2870	1.3550	0.8680	0.4140	0.2470	0.1500	0.1533	0.1440	0.1718	0.2323	0.5520	——
Neshaminy,	Max.....	6.0890	10.047	6.4260	3.7701	6.4200	2.6280	4.7250	2.9440	3.1770	3.9478	5.6240	4.8154	——
below Falls;	Mean.....	2.7307	3.5265	3.3861	1.8749	1.3661	0.7380	0.7320	0.8664	0.7574	0.9933	1.6425	2.0018	——1.7180
139.3 Sq. Mi.	Min.....	0.5110	0.3301	1.4310	0.9000	0.2800	0.0700	0.0440	0.1220	0.0280	0.0360	0.1000	0.3480	——
Tohickon;	Max.....	6.4935	9.6280	7.8030	4.2860	7.5380	5.0690	5.5760	3.4190	4.8860	3.6900	7.1730	6.5718	——
	Mean.....	3.2688	3.9220	4.2121	2.1937	1.4831	0.9075	0.8091	0.9126	1.0962	1.0327	1.7108	2.4061	——1.9962
102.2 Sq. Mi.	Min.....	0.4660	0.0860	1.5840	0.6488	0.1506	0.0650	0.0451	0.0391	0.0250	0.0361	0.1097	0.4911	——

there is considerable ground water storage. The watershed immediately adjoins that of Perkiomen creek, referred to above. Continuous records of flow were not available, but from the record of flood stages found at various points upstream the so-called "30-year" flood was determined to amount to 213 second-feet per square mile, while occasional drought records, including stream gagings taken twice daily during the prolonged drought of 1922-1923, showed a minimum flow of 0.093 second-foot per square mile. It is believed the flow may fall as low as 0.063 second-foot per square mile.

It would be an unjustifiable waste of money to develop a water supply system to guard against the absolute maximum and the absolute minimum conditions. It is the part of wisdom, however, to guard against conditions known to occur at comparatively short intervals.

Overloading Sanitary Sewers

Investigation at Westfield, N. J., indicated that the greater part of the non-sewage flow was drainage from cellars

At the recent annual meeting of the New Jersey Sewage Works Association, Alexander Blair, civil engineer of Westfield, N. J., discussed the question of how the inspection of sewer connections affects sewer maintenance and sewage treatment plant operation, and what agency should be responsible for this inspection; which paper by Mr. Blair was discussed by several of the members.

Dealing with the second part of his title first, Mr. Blair stated as his belief, as a result of his experience, that the inspection should rightfully be in the hands of the engineering department or of the sewage maintenance department, because these departments are the ones that are responsible for the sewers and for the operation of the sewage treatment plants. The engineering department has a much greater knowledge of construction methods and of handling the materials that are concerned; the question of sewage flow, especially when it results in overloading sewage treatment plants, is so important that more observation and tabulation of flows should be done than has been done in the past, and the engineering department or the sewage maintenance force is better equipped to do that than is the health board. A third reason is the misuse at the present time of sanitary sewer systems. The so-called separate systems of sewers are found in the majority of towns, especially the smaller ones, but few actually have separate sewer systems but have only the sanitary sewers with a nucleus only of a storm water system.

Discussions of the overloading of sewers were had in 1903 by the American Society for Municipal Improvements and in 1913 by the American Society of Civil Engineers, both of which attributed this overloading largely to infiltration of ground water. It was stated before the latter society that infiltration into sewer pipes of 30,000 gallons per mile per day may be considered a heavy flow.

Leakage may be found through the walls of manholes or their perforated tops, or where pipe lines cross water courses, etc. Mr. Blair had endeavored to locate the source of flooding in two New Jersey towns, Summit and Westfield, in each of which there was heavy flooding of the sewers at certain seasons. In Westfield, thanks to the sound judgment of Mr. Vars, a former engineer, since 1913 only cast-iron pipe with lead joints had been used for house connections and all of the sewer laterals and mains were laid with the best flexible joints known under rigid inspection. Flood measurements made in 1924 compared with flood flows recorded after investigation by Hazen & Whipple in 1913, show relatively the same high rate of flow in both years, the increase in both normal and flood flows being in almost exact proportion to the growth of the town.

Since the construction work of the past ten years insured tightly jointed mains and connections, it appears that infiltration was not the cause of the major part of the trouble. Moreover, an infiltration of 30,000 gallons per mile would account for only 20 to 30% of the maximum flood flows in storm periods, and the normal sewage flows would be only about 10 to 20% of the maximum flood flows. Naturally, the question arose where the remaining 50 to 70% came from. A survey showed that there were some old houses whose rain-water leaders connected to the sewers, and others where this was possible; but assuming that all of these were connected, this would account for only a small percentage of the flow.

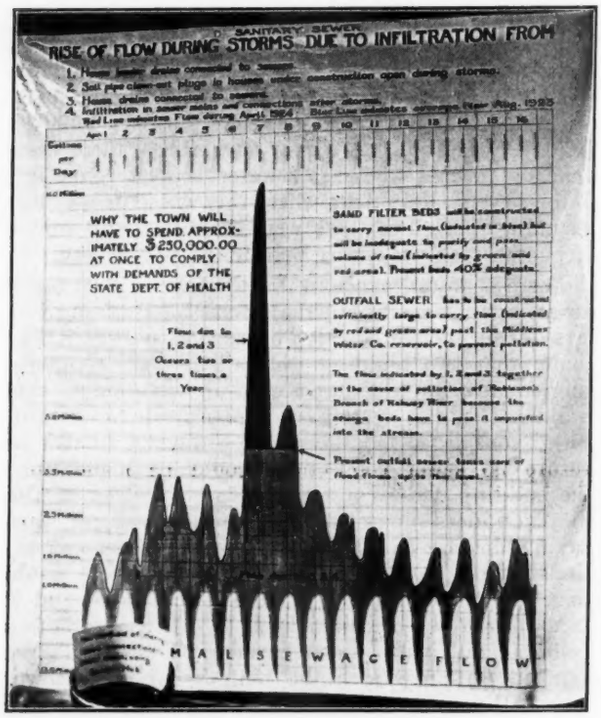
There is an ordinance in this town, as in most other towns, against the use of the sewers for draining cellars during the construction of same. In 1924 it was found that two building excavations were contributing muddy water to the sewer, in violation of this ordinance. The matter was presented to council, which considered modifying the ordinance so that in future no sewer connections could be made until the building under construction had a roof on it. The local builders unanimously protested against this, saying that they could not do without sewer connections when cellers were being dug as they would have no other means of draining the cellars, and it would cost an additional $500 to waterproof a cellar, and with this burden they could not compete in price with the builders of other towns where they were using this method of connecting without hindrance. The council did not care to take the responsibility of checking building operations by

passing the proposed ordinance, and ultimately agreed that the true solution of the difficulty was the construction of storm sewers, and that until they were built it would be difficult to enforce such an ordinance.

Some builders had been using patented traps which, for days after a storm, allowed a surprisingly large amount of water to pass through them. Other builders, after inspection of the house connections by the health inspector, would break a hole in the side of the soil pipe and cover it with a stone or a piece of tin, or leave a trap or small sump in the bottom and then cement the floor over same, thus concealing it.

With a population of about 12,000, the normal sewage flow of this town was approximately one million gallons per day, this being the water consumption. During periods of storms, after the ground had time to saturate, the flow would increase to three and four million gallons per day; while in extreme periods, once a year or oftener, when the ground-water level was high and when frequent and continued storms occurred, the flow has reached as high as ten million gallons per day for a short time. Careful inspection of the system showed that very little water came through the manholes or manhole covers (in the spring these usually had a cover of tar over them), or from brooks or other water courses, from rain water leaders, etc. It was estimated that the normal sewage flow was about one million gallons, that we might estimate two million gallons for infiltration of ground water into the pipes, and about one-half million gallons from roof leaders and traps in cellars.

Assuming the discharge into sewer connections from cellar sub-drains through patented traps and openings in house connections to be about one and a half million gallons more, there would still be a considerable flow unaccounted for, so the cellar excavations were the only reasonable remaining sources and it was assumed that the balance of five million gallons


SANITARY SEWER
RISE OF FLOW DURING STORMS DUE TO INFILTRATION FROM
WHY THE TOWN WILL HAVE TO SPEND APPROXIMATELY $250,000.00 AT ONCE TO COMPLY WITH DEMANDS OF THE STATE DEPT. OF HEALTH
SAND FILTER BEDS
OUTFALL SEWER
MAL SEWAGE FLOW

EFFECT OF INFILTRATION DURING STORMS
Part of exhibit of sewer department at a town exhibit.

and possibly more must be due to this. At that time about 250 houses a year were being built, and the open excavations of houses under construction connected with the sewer would number 75 to 100. Observed heavy flow from several cellar excavations tended to confirm these findings.

In good practice a maximum of 250 to 300 gallons per capita is allowed in designing most systems and any flow beyond these figures endangers treatment plants and causes the waste of large capital expenditures when additional plants and new intercepting drains and outfalls are necessitated. Flooding of sewerage systems causes undue tension in pipe lines, resulting in the giving way of the weaker joints, and in some cases the backing up of the sewage through manholes and into cellars. Flooding of the treatment plant is apt to interfere with the bacterial functioning of the same and the sewage is discharged from it insufficiently treated.

In the discussions, an engineer from Staten Island stated that he had had an ordinance passed by the municipal authorities requiring cellar traps to be placed about a foot above the cellar floor level, which would prevent the draining of cellars or cellar excavations into sewers. Also it would prevent rubbish from the cellar floor getting into the sewers through the trap, which had caused considerable trouble in their town.

Concerning the inspection of sewers, Mr. Molitor stated that he had felt for many years that the divided responsibility of two inspections, one by the health department and the other by the engineering department or sewer maintenance force, was injurious, and he firmly believed that the engineering department or sewer maintenance force should be entirely responsible for the connections to the sewer lines. Mr. Diggs stated that in Baltimore and the Metropolitan District of Maryland, all of the plumbing and house connection work is under the jurisdiction of the engineering department. Where there is the least possibility of storm water getting into the system, they do not allow any connections to be made to the sewer at all from the cellars, although at times they allow washings from laundries and the like to drain into the sewer lines.

Flint's Annual Report

We have received through the courtesy of Harry C. McClure, city engineer of Flint, Michigan, a publication called the "Construction Log," "devoted to the interests of the city engineering department of the city of Flint, Michigan, containing the annual report of the engineering department for the fiscal year ending February 28, 1929, and the first annual report of the sewage treatment works;" this being Number 1 of Volume 5 and dated April. This report contains descriptions of the activities of the engineering department along various lines, some of which we will give in synopsis in separate articles dealing with the several activities of the department.

In sending this report, Mr. McClure says: "A special point has been made of the first annual report of the sewage treatment plant, which has been operated with more than a fair share of success during the past year. It is the largest sewage disposal plant in the state of Michigan—Flint having pioneered in the work of keeping up Michigan lakes and streams to main-

tain the effect which has been of value to the state in attracting the immense tourist traffic to this district.

"The city of Flint undertakes practically all of its own construction work, and a summary of costs on this work is given in the back pages of the book. We particularly want to call attention to the fact that all of our construction equipment, plant, and personnel are carried by job charges, and in no instance are any of these construction activities carried as a budget item or carried by outside funds. In other words, we have handled this construction division just exactly as it would be operated by a private contractor, and have in every way made it self-supporting.

"An item of particular interest in this report is the information regarding the garbage disposal plant, which in this city for a number of years has been by the hog feeding method. We now have the garbage collection and disposal so organized that it is highly efficient with a minimum of complaints, and gives most satisfactory service. The unusual feature of this particular activity is the receipts at the garbage farms for pork sold, showing by the auditor's records an excess of more than $50,000 over purchases. This has resulted in a profit of approximately $25,000 over the total farm expense, and these figures were made possible in face of the lowest pork market in years. In our present year's operation we are planning to carry about 10,000 animals during the summer time, and with a somewhat better pork market (which apparently is to come) we expect to have the gross profit of this farm in excess of $75,000 this year."

Mr. McClure explains that he calls attention to these points chiefly because municipal operation of these services has resulted so differently and with such less satisfaction in other cities and districts. He believes, however, that "if the personnel in charge of these activities will devote the honest effort that our personnel has done, we are quite sure that there will be more satisfactory service generally than is reported at the present time."

The report bears out Mr. McClure's claims as to fullness of information given, while the figures of incomes and expenditures seem to substantiate his claims in this respect. The record of work here presented is certainly a most creditable one and we refer our readers to discussions under separate heads of the activities along the line of garbage collection and disposal, street construction and repair, and sewerage and sewage treatment.

Sewage Treatment at Flint

Description and operating results of largest treatment plant in Michigan. Sewage twenty percent trade wastes from manufacturing plants. Imhoff tanks, with some unusual construction features, give efficiency beyond expectation

Flint began the operation on October 10, 1927, of the largest sewage treatment plant in the state of Michigan. The completed plant will include bar screens, grit chambers and sewage pumps, in a pumping station located within the city, to pump the sewage to the treatment works, which are located on a 135-acre tract of land about one mile northwest of the city limits, the nearest dwelling to which is about one quarter mile distant. At present the treatment is confined to sedimentation in Imhoff tanks and drying the sludge, but it is proposed to add secondary treatment of the effluent, probably in the form of sprinkling filters.

Flint has a population of about 150,000. It is primarily an automobile manufacturing city, and the industries contribute much oil and grease and both acid and alkaline trade wastes to the sewage, although a considerable part of these is disposed of by the industries themselves. Very little storm water reaches the sewers through rain-water leaders, and the average flow is only 9.62 million gallons per day from a connected population of 120,000.

The effluent from the treatment works is discharged into Flint river, which has a drainage area above that point of 980 square miles and the flow of which varies from a minimum of 82 second-feet to a maximum of 1,400 second-feet, on a monthly basis. The absolute minimum recorded was in October, 1920, namely 58 second-feet, and probably even smaller flows have occurred at times. During low flow the stream was badly polluted and there were unsightly sludge deposits and bad odors, and the State Board of Health several years ago ordered the city to take measures to prevent these, which it has now done.

At the pumping station are two screen and grit chambers built parallel. The pumping equipment consists of two 10 m. g. d. and two 15 m. g. d. "American" sewage pumps, electrically driven with 125 h. p. and 200 h. p. motors. To provide against possible failure of the electric power, there is an auxiliary plant consisting of a Worthingtion 17 x 25 crude-oil, full Diesel engine connected to a 250 kva Westinghouse generator. This unit is used for a short time daily to reduce the peak of consumption of electric current and thus materially reduce the power demand charges.

The pumps force the sewage through a 50-inch riveted steel force main to the treatment plant, where it passes through a 50 by 29-inch Simplex venturi meter. At the gate house the sewage rises in a surge well and flows over low weirs into two channels, each of which connects with a 30-inch cast iron pipe line which leads to two of the four Imhoff tank units. At present the effluent from the Imhoff tanks is discharged directly into the river.

IMHOFF TANKS

Each of the four Imhoff tanks is designed for a capacity of 4 million gallons per day, and is operated

on the radial-flow plan. Each tank consists of 18 hexagonal cells, 6 in an inner ring and 12 in an outer ring. Sewage is brought into the tank at the center, divides and flows radially in every direction with a velocity decreasing as it approaches the outside wall, where it is drawn off through 12 orifices placed around the wall, each orifice consisting of a 3 x 8-inch opening in a steel plate placed over the outlet of a pipe tee in a vertical riser pipe. These orifices are so adjusted that each will pass the same amount, so that the flow of sewage from the center of the tank to the outer wall will be uniform in all directions. Advantages of this arrangement are that the unusually low rate of sewage flow through the sedimentation compartments near the outlets aids in the removal of the finer suspended particles, which would not settle out in a tank giving a constant velocity through the sedimentation compartment; and that the gradual reduction in velocity tends to stop eddy currents and thus increases the settling efficiency. The tops of the outlet pipes are left open as an emergency overflow and a scum baffle is placed around each orfice to prevent oil, grease and other floating material from going with the effluent to the filters.

Near each outlet orifice a skimming gate, fastened to the tank wall, skims off floating oil and grease and discharges them through the sludge pipe on to sludge beds set apart for this discharge. These gates consist of 12 x 12-inch downward-opening sluice gates, so designed that the top of the gate acts as a skimming weir.

The sedimentation compartment of each tank is designed for a 4 mgd. rate, figuring a three-hour detention period with 4 million gallons assumed to come in 18 hours, giving a nominal 4-hour detention period based on the average flow for 24 hours.

The sludge compartment of each tank is divided into 18 hexagonal pockets, one at the bottom of each cell. The inner row of pockets receives the heavier and more quickly settling sludge, which may be discharged by an air lift into one of the outer pockets, which transfer improves and shortens the digestion process and eliminates the necessity of periodic reversal of flow. Sludge can be drawn off by gravity from the outer pockets to the sludge beds. The total sludge volume provided for is based on the unit of 2.75 cubic feet per capita, with each tank designed for a population of 40,000.

The gas vents, one in each cell, cover 10½ per cent of the total area of the tank. They are carried up to a point 5 feet above the normal sewage level and 2 feet above the side walls.

There are 40 sludge beds each 24 by 125 feet, built with tile underdrains covered with gravel and sand, with division walls of cypress planks held in place by means of pre-cast slotted concrete posts. The total area of sludge beds gives 0.75 square foot per capita of tributary population. A 24-inch gauge industrial track is laid in each bed and connected to a track surrounding the plant, which leads to a ravine nearby where the sludge is dumped.

Water is supplied for the plant by means of a deep-well pump with a capacity of 50 gallons per minute, which pumps into a 50,000-gallon elliptical-bottom elevated water tank.

The cost of the plant was $17,433 for land, etc., $219,650 for the pumping station, $268,560 for the pressure main, and $541,887 for disposal plant, giving a total cost of $1,047,530. It is estimated that an additional $500,000 will be required for completing the plant for secondary treatment.

OPERATION OF THE PLANT

The plant had been operated for fifteen months at the time of the latest report. During that time the maximum amount of sewage received in any one day was 16,180,000 gallons following a steady two-day rain, while the minimum amount of 6,250,000 gallons was on the last day of a dry month. The comparison of the sewage flow with the rainfall record would indicate that the fluctuation in sewage is due more to ground water than to storm water from roof drains, etc. This is shown by the peak flow in April when the spring thaws occurred, the precipitation being practically the same as during the previous month; whereas after April, when the ground had thoroughly thawed out, the sewage flow followed the precipitation closely, probably due to a combination of roof drains and ground water, although the effect of the ground water would not be as great as formerly, owing to the dry condition of the soil. In fact, during the peak precipitation in October, which was taken up by a very dry soil, there was little effect on the sewage flow until the following month. Roof drains still have a considerable effect on the sewage flow, however, for it is seen that in general a peak of sewage flow follows within a half-hour after each peak of heavy rainfall.

The sewage as received at the treatment works is septic, dark colored, considerably above the average in concentration as compared with sewage of other cities, the average total solids being 928 parts per million and the average suspended solids 255 p.p.m. Biochemical oxygen demand is very high, the five-day demand averaging 326 p.p.m. The septic nature also causes strong odors and is the subject of considerable study and research at the plant.

The population equivalent of the raw sewage, as computed from the customary value of 0.17 pound of oxygen demand per capita per day, gives an average equivalent contributing population of 152,000. As the actual contributing or connected population is only about 120,000, the local sewage is about 1.27 times as strong as the average sewage; or in other words, the industrial waste adds the equivalent of the sewage of 32,000 people. The pH varies from 7.0 to 8.2, the oxygen consumed from 36 to 126, the five days b.o.d. from 132 to 955, total solids from 663 to 1808, the total organic solids from 209 to 1443, the suspended solids from 88 to 976, the suspended organic solids from 52 to 780, the turbidity from 125 to 800.

The regular operating force at the treatment works consists of the chemist in charge, an assistant chemist, two attendants, and one laborer, with additional laborers employed during the summer months to dispose of the sludge.

The efficiency of the Imhoff tank in removal of solids exceeded expectation, the average removal for the year being 66.7 per cent, but for the last six months nearly 75 per cent, the low average during the early months having been due to reduced efficiency during May and June owing to initial operating difficulties, mostly foaming.

The solids in the sediment appear to be distributed very uniformly both throughout the tanks themselves and between the inner and outer rings of cells of each

tank, which are interconnected. The accumulation of solids in the inner cells seems to be slightly in excess of that in the outer cells, but a difference in depth greater than one foot has never been found. During the last two months of the year sludge was transferred once every two weeks from the inner to the outer cells of one of the tanks for experimental purposes. There appears to be very little difference, however, in the digestion of the sludge in the inner and outer cells. One indication of this was that when the tanks started to foam, all cells foamed practically simultaneously. Analysis of the sludge in the two sets of cells shows little difference in moisture or organic content.

The average reduction in organic matter in the sludge due to liquefaction and gasification during the year was 60.8 per cent, while the reduction in dry solids for the same reason was approximately 26.9 per cent. The organic content of the raw sludge, which averaged 71 per cent, is rather low for a sewage of this type, which may possibly be due to silt washed down with the storm water.

Foaming, which started in April and continued until June, was undoubtedly due to the time of year in which the tanks were placed in operation. Being started at a season when digestion is extremely slow, the tank became filled with raw undigested solids which, when the temperature became more favorable for digestion, proceeded to digest rapidly.

An oil separator was built consisting of a wooden box mounted on an industrial truck, into which all skimmings are drawn before discharging to the bed. All oil is retained in the tank, the water escaping to the bed from an underdrain swing pipe. When the tank is filled with oil it is taken to a dump and the oil is discharged by lowering the swing pipe. This contrivance has satisfacorily solved the problem of disposal of oil and skimmings. The tanks are skimmed as often as is necessary to maintain good appearance, and all oil adhering to the tank walls is scraped off. The tank slots are cleaned with a chain pole when the occasion demands. All sludge lines are thoroughly flushed with water after use and any sludge slopping on to the masonry is washed off.

During the last six months of the year, when operation was normal, the oxygen consumed was reduced by the tanks 41.4 per cent, the 5-day b.o.d. 54.1 per cent, total solids 22.2 per cent, total organic solids, 27.8 per cent, suspended solids 74.8 per cent, suspended organic solids 72.3 per cent, settleable solids 93.5 per cent and turbidity 60 per cent.

Sludge was drawn on to the drying beds for the first time on April 5, 1928. It was well digested, had little odor, and dried well considering the time of year. The average analysis of the wet sludge shows 92.9 per cent moisture and 49.1 per cent organic. All sludge beds were filled to an average depth of 12 inches. The average shrinkage of the sludge on the beds was 71 per cent; the average drying period was 33 days, with a maximum of 77 and a minimum of 9 days.

The total operating costs from March 1 to December, 1928, when a full operating force was employed, were: Pumping station, $40,090; disposal plant, $21,427. The cost of operating the disposal plant was divided as follows: Labor, $15,877; power, light, etc., $1,275; supplies, $1,985; special equipment, $167. On these figures and corresponding ones for pumping as a basis, the total cost of operation for a year of both pumping station and disposal plant would be approximately $57,670, or 48c. per capita of connected population, or 38c. per capita spread over the entire population of the city.

The engineering department advocates the plan of paying for the operation by assessing the cost against water users. As the revenue for 1928 was approximately $1,057,000, the cost of sewage treatment was 5.46 per cent of the water revenue; that is, the citizens could pay for the operation of the sewage plant by increasing their regular water bills by 5.46 per cent.

The chemists in charge of the plant have been carrying on investigation and research, including a small experimental filter, an experimental garden to determine the value of Imhoff sludge as a fertilizer; experiments to determine the best paint to use about the plant where subject to sewage fumes, gases, etc.; a study of the industrial wastes issuing from the individual manufacturing plants and the best methods of disposing of them; locating and preventing odors in the sewer system throughout the city; and a thorough inspection of the river for 30 to 40 miles below the city about every eight days, to keep track of the effect of the sewage effluent on the river, especially on the oxygen content.

Underdrained Sewers at Rye, N. Y.

To eliminate infiltration, a fifteen-inch subdrain was laid under a ten-inch sewer, and still carries three times the normal sewage flow.

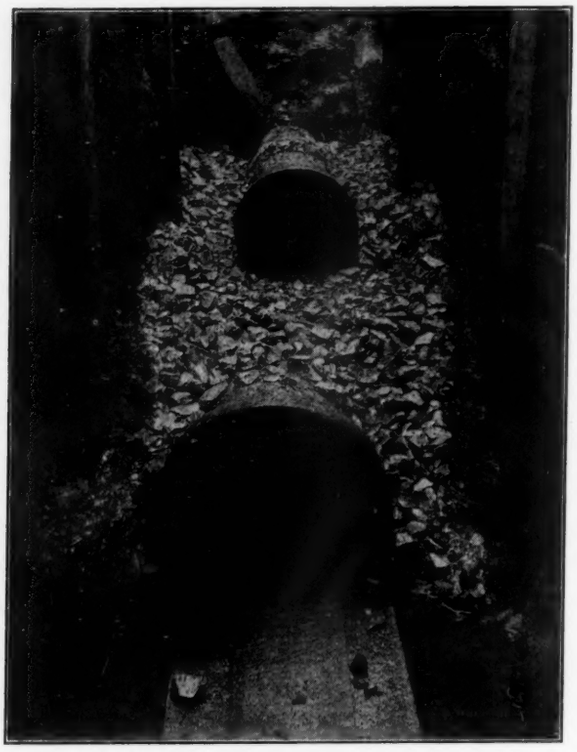
By Henry W. Taylor*

Sewers were constructed in 1927 in a small sewer district of the town of Rye, N. Y., which lies just west of the west corporation line of the village of Port Chester, New York, and in which a large percentage of the digging was in wet soil. The district commissioners had arranged with the village of Port Chester to receive the drainage from the district and treat it at the village disposal plant on a lump sum basis plus a small yearly charge for pumping and plant operation. Under these conditions, it was important that infiltration should be eliminated in so far as possible.

There were also structural features connected with the wet soils to be encountered and it was feared by the engineer that good alignment, bearing and joints would be difficult to obtain except with special precautions. A large variety of soils, sloppy when wet but of good bearing values when free of water, were known to exist, and it was found later that the rock cuts exposed rock seams which were full of water under pressure.

Many properties were already underdrained with land tile, which connected to blind drains and ditches, and cellar flooding from a high ground-water table was a frequent occurrence. In fact, the situation warranted the opinion of the commissioners that underdrainage would produce a benefit to the district comparable to the benefits of the sanitary drainage, and consequently all interested parties were more

*Consulting Engineer, New York City



RYE SEWER AND UNDERDRAIN

than willing to listen to the engineer's argument that a system of underdrains was hydraulically and structurally necessary.

It was also considered that, were the contractor allowed to use the underdrain for draining the trench during construction, its cost would be largely discounted by the reduction in the contractor's allowance (or gamble) as to pumping costs on the work. This forecast was practically realized, as agreed by the contractors who bid on the work.

The use of the underdrain was amply justified, as proved after construction, by the following benefits:

(1)—The sewers were laid on dry stone or gravel fill in perfect alignment and good bearing. A lighted match could be seen through a ten inch sewer 350 feet long.

(2)—The sewer joints were run dry in every case, the water level being over a foot below the sewer invert. The ground water level in the sewer trench is still, of course, below the sewer invert and infiltration is impossible. The tightness of the sewer joints is, however, indicated by the character of the underdrainage water. The water level in the whole district has been materially lowered and the ground conditions greatly improved. The underdrain was, in fact, blamed for the depletion of wells.

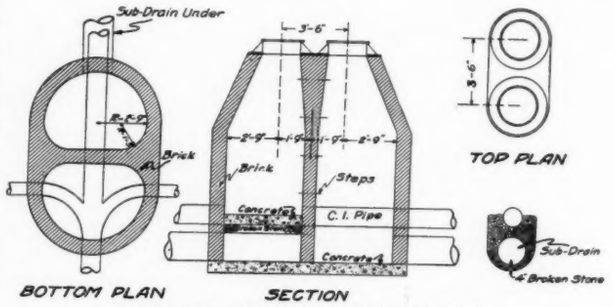
(3)—Existing drains, which formerly connected with blind ditches and drains which were located with difficulty and were subject to stoppage, were connected to the underdrain in a permanent and satisfactory manner.

(4)—The contractor was afforded a means of taking care of the ground water without pumping expense and this means was of ample capacity and not subject to motor or pump trouble. I consider that the cost of the drain was about balanced by the omission of the major pumping allowances from the contractor's bid.

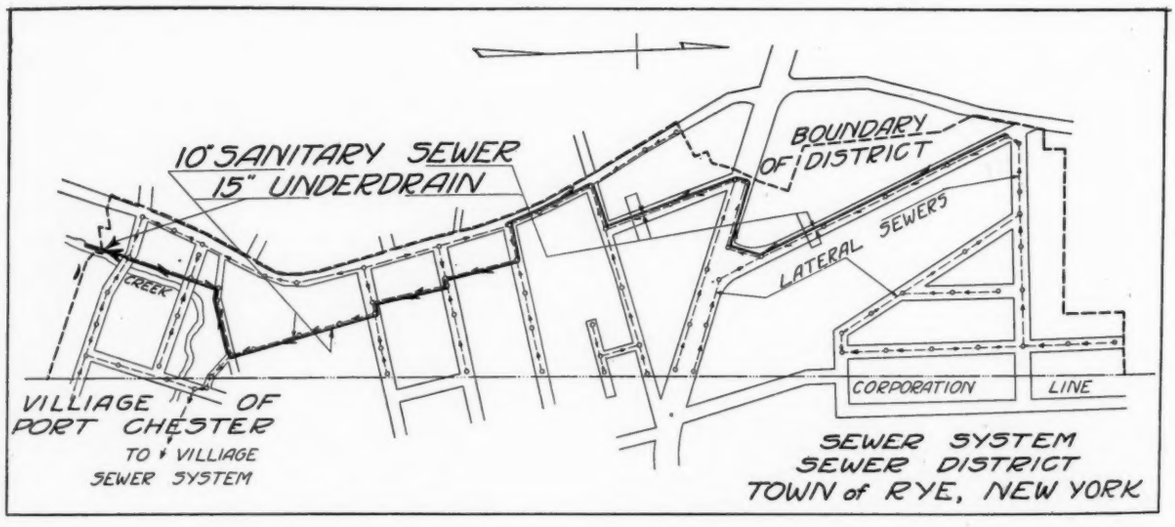
Spot pumping for joints would not have produced a satisfactory job, and I would have feared settlement of pipe, broken pipe, weakened joints and ground water infiltration, eventually, if not immediately after construction.

(5)—The district is not burdening the Port Chester pumps and disposal plant with ground water, but is delivering to the Port Chester trunk line an undiluted sewage.

The writer had an opportunity to see the discharge of the underdrain in April 1929, and found a flow



DETAIL OF DOUBLE MANHOLE



still maintained, eighteen months after construction, in an amount at least three times that of the normal sewage flow from the district as now populated. The water was cold, clear ground water, without a cloud from any sewer leakage. The underdrain was made large enough, as it now appears, due to the fear of the district residents that the flow would be considerable and continue so indefinitely.

The fifteen-inch tile comprising the underdrain was laid in two foot lengths, with open joints, just free of the bells of the sanitary sewer. Three inches of clean gravel or crushed stone from one-half to one inch in size was first placed in the bottom of the ditch, and the same material was backfilled around and over the tile up to the bed of the sanitary sewer. The sewer pipe men were, therefore, working on dry stone when they laid the sanitary sewer. The sanitary sewer was back-flled to its horizontal diameter with stone. A double manhole was constructed to afford a compartment for inspection and clearing of the underdrain, as well as of the sanitary sewer. The drawing shows this combination manhole. At angles, the underdrain was deflected slightly so as to reach its compartment of the manhole.

The plan of the sewer district indicates the adaptability of the topography of the southern section of the area to this underdrain scheme. A small natural water course afforded an outlet for the drain without pumping or long outfall. However, had this natural outlet for subsoil drainage not been available, the writer would have considered it futile to attempt the construction without an underdrain supplied by the owner, which drain would perhaps be used during construction only, but would afford facilities for sectional pumping of the trenches and adjacent area at say thousand-foot points. Bell hole pumpage in wet soils, whose bearing value and stability are affected by the presence of moving water, is often unsuccessful. It is a risk to the joint and to the permanence of the pipe itself, and to its alignment. It is the writer's opinion that much inferior sewer work results from the refusal of the owner to pay a small additional price for such facilities during construction, at least, as will make a good job easily possible.

Road Maintenance in Alameda County

How it was installed and carried on under the charter form of government in this California county. Substituting motor equipment for horse-drawn effects great saving. Oiling replaces sprinkling

By C. H. Thomas*

Two years ago the maintenance of all roads in Alameda county was turned over to the county surveyor's office by a provision of the newly adopted charter of that county.

Previous to this time, all such work had been under the direction of two members of the County Board of Supervisors and as these men had many other duties, the road work had been more or less desultory and without much organization. Each supervisor appointed a number of roadmasters, whose duties consisted of maintaining the roads in the particular districts in which they lived.

As little or no cooperation existed between these men, each roadmaster's organization was a separate unit, with its own equipment, which resulted in multiple duplication of the necessary tools and machinery. Roadmasters who had more time than others to work on the roads were likely to get all of the road money, while other districts, equally important, were neglected.

REORGANIZATION ON A COUNTY BASIS

When the county surveyor's office took over the supervision of maintenance, the first step was to make a complete inventory of all the tools and machinery on hand. This consisted of some extremely antiquated and nearly useless two-horse graders with 6-foot blades; a large fleet of two-horse sprinkling carts, nearly all of which were in a sad state of repair; a Fageol truck in fair condition; three old Pierce-Arrow trucks, and a one-cylinder gas roller (out of commission). Nearly all of the roadmasters had an adequate supply of small tools, but with much unnecessary duplication.

* Maintenance Engineer, Alameda County, Calif.

Our next step was to motorlog and classify all the roads in the county, and to map same under each road district. Drainage structures, water systems and other accessories were located, investigated and classified. During the many months required to complete this work, forms for many different types of reports were evolved and a system of accounting installed.

As all of the field forces were untrained men, it was necessary not only to train them to new methods but also to break them of old habits of work that were both expensive and obsolete. No cost records had been kept prior to this time, which made it nearly impossible to ascertain what had been done in the past, but it was fairly certain that the maintenance activities had consisted mainly of three operations: scraping the roads with light two-horse graders; applying thousands of tons of loose gravel; and sprinkling the roads with the old horse-drawn sprinkling carts. All of the roads that were not paved had, under this system, assumed a distorted section with a high, dangerous crown, and, although sprinkled, were nearly always dusty and rough-riding.

MOTORIZING THE EQUIPMENT

During the first year of our supervision, six one-man motor patrols, equipped with the "Caterpillar" 2-ton tractor, were substituted for the horse-drawn grader. Also, two new super-grader units, consisting of a 60 "Caterpillar" and a heavy super-grader, were purchased; these being used exclusively in tearing up and reshaping the distorted sections to a standard section; after which the smaller patrol units are used for maintenance only.

TYPE OF SUPER-GRADER UNIT IN SERVICE

We found that the cost of grading a 20-foot roadway with a two-horse grader was about $1.50 per mile under the most perfect conditions, and sometimes ran as high as $2.50 per mile. This can readily be checked by assuming that a two-horse grader with a 6-foot blade must make four trips over a 20-foot section in order to shape it properly and leave no ridges of loose gravel when finished; requiring four miles of travel for every lineal mile of road graded. If the team worked at a speed of two miles per hour, including the necessary stops to rest the team, in eight hours working time a team would grade only four lineal miles of road.

If the time going to and coming from the job be deducted, this leaves, at the most, about seven hours working time. The pay for these units is $6.00 per day for a two-horse team and driver, and $4.00 per day for the grader man, making $10 to grade four miles of road, or $2.50 per mile.

The one-man units cost $10.50 per day, which includes salary of operator, gas, oil and repairs, with nothing added for depreciation. The motor units leave their respective bases in the morning in time to be on the job at eight o'clock in the morning, and return to their bases on the county's time, making about 7½ hours actual working time in the field. The machine will cover a 20-foot section in three trips at a working speed of about four miles per hour, thus traveling 30 miles, or 10 lineal miles of road graded, at a cost of $1,00 per mile; a saving of at least 100% over the horse-drawn method, to say nothing of the additional service given to the tax payers in additional mileage of roads graded. The average cost per mile, taken over a period of one year and for all roads of various widths, was $0.65 per mile.

Most of the horse-drawn sprinklers were discarded and four trucks purchased, on which sprinkler tanks of 1,000 gallons capacity were mounted during the summer months, which resulted in similar economy.

Before putting on the motorized equipment there were 25 horse-drawn carts in service, which cost $300 per day to operate, exclusive of repairs. The 5 trucks and 7 carts which replaced them cost $182 per day, including all repairs, a saving of $118 per day during six months in the year. Moreover, the trucks are used with dump bodies in the winter, while the sprinkling cart stands idle for six months in the year as a sort of perpetual monument to obsolete methods.

Noticeable economies have been effected in the repair of improved roads also. Under the old system, each roadmaster had his own repair unit, generally consisting of a one-barrel, wood-heated tar kettle for asphalt, a horse-drawn wagon for his screenings, and an old tea kettle or pail for a pouring pot. At the time the roads were taken over there were twelve such outfits and twelve different methods of doing the work. Cracks in concrete pavement usually were filled by pouring hot tar over and around the crack until, after a short time, a bump of appreciable dimensions was formed, which later had to be burned off at no little expense.

Holes in oiled roads were repaired by digging out the hole, filling it nearly full of hot asphalt, adding a few rocks for good measure, and calling it a job; thus making a sore spot that bled terribly in hot weather.

USE OF EMULSIFIED ASPHALT

This has been entirely discontinued, and no hot oil whatever is used in this county for light maintenance, except occasionally for crack filling on concrete roads. After considerable experimentation, an emulsified asphalt was adopted for such maintenance. This is a cold laid product, and as the emulsion agent is largely pure water, it can be successfully worked with in wet weather.*

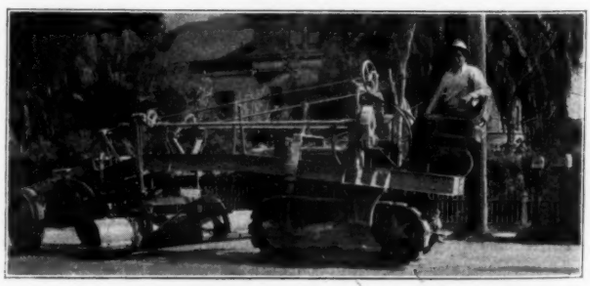
Two fast motorized outfits have replaced the twelve old hot-kettle units, these two outfits taking care of about 120 miles of improved roads.

The first of these units consists of a 5-ton pneumatic-tired Fageol truck, specially built and with specially built tool boxes and equipment, and a 750-gallon trailer for the transportation of oil. The crew consists of a highly trained maintenance foreman, a truck driver, and two laborers. This crew has about 80 miles of concrete, asphalt, oil-macadam, and oiled surface roads to care for, and at no time so far have they been unable to keep up with their work.

The trailer for this unit was built in our own machine shops from an old steel sprinkler tank and a discarded truck frame, and has several features that might be of interest. On each side of the main tank (which contains the emulsified oil) there is mounted a smaller tank, capable of holding compressed air up to 120 pounds pressure. The outfit is equipped with a regular boot and spray, capable of being worked in 2-foot units, each independent of the rest of the boot if so desired. When it is desired to use this spray, pressure is set up inside the main tank by releasing enough of the compressed air from the auxiliary tanks to bring the main tank to the pressure required. As these auxiliary air tanks can be blown up at any service station, it will be seen that this arrangement does away with the often troublesome pump and power take-off used on standard oilers.

The second maintenance crew, consisting of a foreman, driver, and one man, is equipped with a 2-ton Fageol Flyer without the trailer, and successfully keeps up 40 miles of improved roads. Both outfits are capable of an extreme speed of 35 miles per hour

* See article "Emulsified Asphalt for Road Work" on another page of this issue.



TYPE OF ONE-MAN PATROL USED IN THE COUNTY

under full load, which is a feature adding largely to their effectiveness.

OILING REPLACES SPRINKLING

An effort is being made to do away with the old method of dust abatement by sprinkling. There can be no doubt that this is wholly antiquated, expensive, and entirely unsatisfactory, as, in a climate where the thermometer frequently reaches 100 degrees, the effects of sprinkling are most transient, the road surface usually being perfectly dry and dusty twenty minutes after the sprinkler has passed.

It was found that it cost approximately $250 per mile to sprinkle seasonally, and another $250 per mile per year to maintain by grading and gravelling; both processes falling short of attaining the desired end, the sprinkling being nearly useless, and the grading and gravelling failing to keep the dirt road smooth and dustless under heavy traffic. Thus, the $500 per mile could be said to be about 75% wasted, neither process providing even semi-permanent benefits for the motoring public.

With this in mind, we have adopted surface oiling for our secondary roads, which is being carried on with all the speed compatible with the funds at our disposal; so vigorously, in fact, that in the last two years 34 miles have been so surfaced, with a further program of about 20 miles planned for this year. The saving in sprinkling and maintenance funds on these 55 miles of road will soon be piling up to aid us in further work of a like nature, until it is now possible to look forward confidently to an annual saving of over $30,000 in sprinkling costs alone.

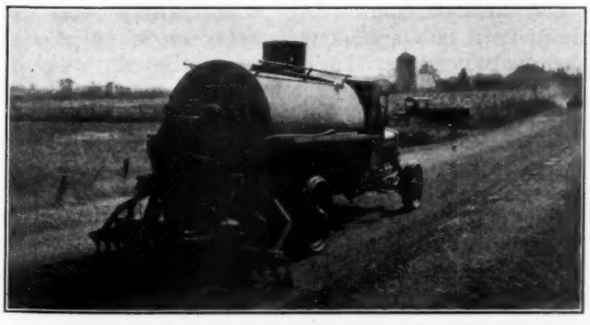
(The type of oiled surfacing used and the method of applying it are described in the article "Emulsified Asphalt for Road Work.")

Unless the oiling is being done for one-half the roadway width only, it is advisable to close the road while the work is being done, in order to prevent peeling off of oil.

The cost of this process as contracted for has varied from $0.0143 to $0.0225 per square foot according to the location of the work, but that part of the work done by county forces has averaged about $0.017 per square foot, which could safely be taken as representing a fair average cost.

The entire maintenance organization is under the direction of George A. Posey, county surveyor and road commissioner, a man of large vision, quick to grasp new opportunities for economies, and bold enough to try any reasonable experiment that bids fair to show an improvement in method or economy in practice. We have also been very fortunate in having the full and enthusiastic cooperation of a Board of Supervisors, who have been most generous in supplying us with the necessary funds for this work of reorganization.

With a continuation of this program we may confidently look forward in a few more years to a dustless and mudless county whose rural roads will be second to none in the country.



APPLYING A COAT OF EMULSIFIED ASPHALT AT THE RATE OF ¼ GALLON PER SQUARE YARD OF SURFACE.

Note that the careless operator is missing about two feet of the outer edge of the road, which he is required to cover later by hand hose.

THIS IS THE PROPER WAY TO SPREAD SCREENINGS

Emulsified Asphalt for Road Work*

By C. H. Thomas†

Until a few years ago it was the custom in Alameda county, California, either to improve a road with some high type of pavement such as concrete, asphalt, or oil macadam, or to leave it without any treatment. As the volume of traffic over many of the roads did not warrant the high-cost pavements, they were left untreated; although the dust from them caused dust-blighting of fruit and vegetables of orchardists and truck gardeners.

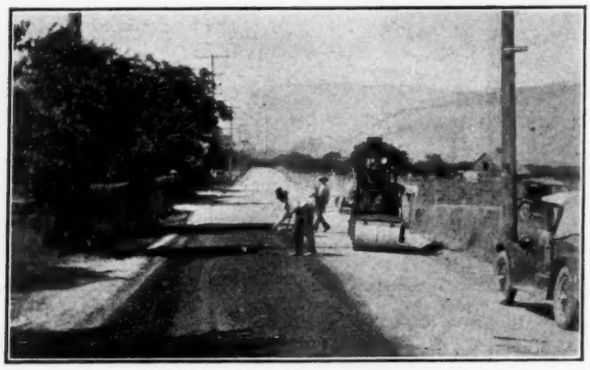
Oiling was tried twenty years ago but had proved to be wholly unsuccessful. Recently another attempt was made with the later methods of oiling, the road being swept perfectly clean, hot oil applied at the rate of one-quarter gallon per square yard, allowed to stand for two or three days to soak in, then another coat of oil applied and covered with screenings. This treatment cost about $1,100 per mile. As the sub-base of one of the roads so treated lacked sufficient stability, it went to pieces very quickly. In addition, automobilists complained bitterly against the splashing of oil onto their cars. Two other roads were held together, but at the high maintenance cost of $27.50 per mile per month for a road carrying about 300 cars daily.

Early in 1927 it was decided to try emulsified asphalt, and a contract was let for surfacing Niles Canyon, a road seven miles long which was to be used as a detour to Oakland during the construction of a part of the state highway, which carried over 4,000 cars a day. This work was let by contract and was carried out during June, 1927.

The roadway for a width of 20 feet was swept per-

*Abstract of a paper before the League of California Municipalities.

†Maintenance Engineer of Alameda County, California.

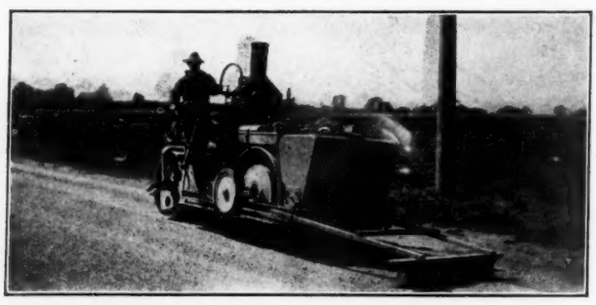


ONE-HALF OF THE SURFACE FINISHED AND READY TO ROLL WITH LIGHT ROLLER

fectly clean with the use of power-driven brooms and an application of emulsified asphalt was made at the rate of one-quarter gallon per square yard. Immediately afterward a course of crushed rock graded in size from ¾ inch to ¼ inch was applied at the rate of 120 cubic yards per mile or about one cubic yard for 100 square yards of surface. On this another application of emulsified asphalt was made at the same rate and this was covered at once with a light spread of "birds-eye" screenings applied at the rate of about 100 cubic yards per mile or one cubic yard per 120 square yards of surface. The whole was then lap-rolled with a 3-ton roller and opened at once to traffic. This work was contracted for at the rate of 2c. per square foot, but Mr. Thomas believed that an organization with fairly skilled workmen could lay it for about 1½c.

From his experience with this treatment, he believed that only in cases where the dust is over ¼ inch deep is it necessary to sweep the road. If the road is hard and firm, a thin film of dust does no harm whatever. The only precaution necessary in such cases is to sprinkle the road thoroughly just before the application of the emulsified asphalt. Whether swept or not, sprinkling is recommended, the emulsified asphalt taking a better hold on the wet surface than on one that is dry.

The first result noticed was that there were no complaints of cars being splashed with oil, as there seemed to be no tendency for this material to be picked up by vehicles. Traffic used this road at the rate of about 4,000 cars a day for a year after this treatment, 15% of the traffic being heavily laden trucks. On Sundays and holidays, the peak traffic ran as high as 12,000 cars a day. At the time of writing this paper, fifteen months after the treatment, the surface was still in place and Mr. Thomas believed would be serviceable



THE COMPLETED SURFACE

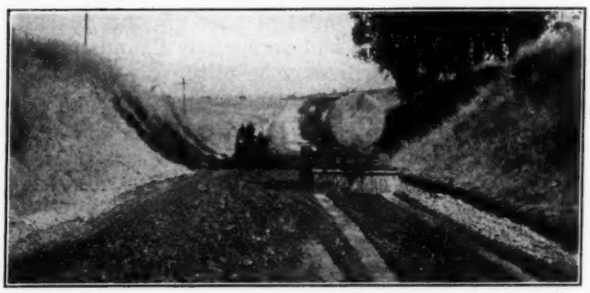
for another two years. It still retained its original life and ductility, although a portion of a road treated with 60-70 hot oil had lost practically all of its life, being brittle and crumbly.

The maintenance cost of this piece of road while it was carrying heavy traffic was $16.30 per mile per month, which included all of the winter months of 1927-1928. When the traffic was turned back onto the main state highway and the traffic on the road reduced to 500 cars per day, the maintenance cost dropped to $8.25 per mile.

The special value of the emulsified asphalt, so far as maintenance is concerned, is realized in the winter months when the winter rains keep the roads so wet that it is practically impossible to repair them with hot asphalt. Patches made with the emulsified asphalt on the emulsified road during the winter rains seemed to have stuck just as tight as those put in during the dry summer weather. The patching crew simply swept the water out of the holes, applied the emulsified asphalt, adding the necessary rock, tamped the place slightly and went on to the next one.

THE TURN-OVER OR MIXING METHOD

After the success of this road, it was decided to try emulsified asphalt in the turn-over or mixing method,



AFTER SCARIFYING THE ROAD TO A DEPTH OF TWO INCHES, SUFFICIENT WATER WAS ADDED WITH A POWER SPRINKLER TO THOROUGHLY MOISTEN THE MATERIAL

and the makers, after a number of experiments, evolved a product for this purpose known as "superbitumuls." A contract was let for using this material on six miles of rural roads which were too loose to permit of the use of the surfacing method and on which it would have been necessary to spend a great deal of money bolstering them up with gravel and compacting them. It seemed necessary to have a road oil of high asphaltic content to take care of the excess of fines in the road, and one of such consistency as to stand up under the mixing process without breaking down until it had been thoroughly incorporated with the roadway material. This was believed to be the first work of its kind ever attempted with emulsified asphalt.

The roadway was first scarified to a depth of two inches, after which sufficient water was applied with a power sprinkler to thoroughly moisten the material. The sprinkling was to prevent the excessive fines from drawing the water out of the emulsion too rapidly and thus causing a too rapid breaking down of the oil before the mixing had been completed. Five gallons of water per square yard was used on this road, but the amount of water required is wholly dependent upon the amount of fines in the surfacing being treated. The ideal condition striven for is to obtain a grade

in a thoroughly moist condition, being more mealy than actually wet, and under no circumstances to be muddy or stuck together. On another road where the gravel content was almost ideal for an asphaltic concrete mixture, only about half this amount of water was necessary. Great care should be taken in getting exactly the right amount of water, since this is a big item in the final success of the work.

When the surface was in the right condition of dampness, the first application of oil was made at the rate of one-half gallon per square yard and thoroughly harrowed into the grade. Another application of emulsified asphalt was made at the same rate and treated in like manner; after which the entire mass, containing two applications of oil, was bladed into windrows at the side of the road. The exposed base was then given an application of oil at the same rate and the windrows bladed back over the surface to the desired section. If the harrowing has been performed properly, there will be little need of turning the surface more than once with the blade. One turning only is desirable in warm countries where, if the material is turned too often, it will dry out too rapidly and hasten the breaking down of the emulsion before the grade has been properly worked.

FIRST APPLICATION OF EMULSIFIED ASPHALT, SHOWING THE MANNER OF IMMEDIATE TREATMENT WITH SPRING-TOOTH AND DISC HARROWS.

After the roadway had been bladed to the desired section, it was lap-rolled with a light roller for the purpose of bringing all of the free moisture to the surface. On this particular road the moisture did not evaporate sufficiently until after two or three days, and it was necessary to continue rolling until there was no longer any movement in the grade or marking under the 12-ton roller. Mr. Thomas does not advise permitting the road to be compacted by traffic, since the compaction will then be uneven, requiring continuous blading; and it is just as cheap to continue the rolling as it is to continue the blading, with the added advantage that a grade that is rolled thoroughly is subject to much less loss of road metal than is a grade which is loose for some time under traffic. There is no danger of over-rolling so long as there is any moisture in the grade or it will mark under the roller.

This road had not been completed a sufficient length of time to determine its success, but it appeared to be very promising. It cost about $1800 per mile under contract, but the actual cost was about $1500. Of two roads so treated, one contained only about 30% of road metal and the maintenance on this road cost $9.30 per mile per month; while on the other road containing 60% road metal, no maintenance whatever had been necessary.

This method of treatment with this material seems to be especially applicable to streets and roads where extensive gravelling or compacting would be necessary for the ordinary hot-oil treatment.

APPLYING OIL BY POWER DISTRIBUTOR

Distributor had insufficient power to propel itself through the loose grading material and had to be helped with a "30" caterpillar.

This asphalt was tried in skid-proofing an asphalt pavement which had been very slippery, being too rich in asphaltic oil, at a point known as "Death Curve," where at least 200 accidents had occurred, two of them fatal. A tack coat of emulsified asphalt was applied to the surface at the rate of one-quarter gallon per square yard and a layer of crushed rock applied, the rock ranging in size from 1¼ inches to ¾ inch, distributed at the rate of 70 pounds per square yard, or so as to be about one stone deep. Another application of emulsified asphalt was then made at the rate of ¼ gallon per square yard, followed by a very light application of screenings ranging in size from ¾ inch to ¼ inch, at the rate of about 20 pounds per square yard. The whole was then rolled with a light roller. During the six months since this work was done not an accident has been reported. It is believed that it would be better to use only one-eighth gallon per square yard for the second coat.

Emulsified asphalt has been used for winter patching and where, with hot asphalt, it was necessary to carry six maintenance crews with kettles, the county is now able to get along nicely with two crews covering the same territory, maintenance costs have been cut in half and the time and expense of heating oil have been saved.

APPEARANCE OF GRADED SECTION BEFORE LAP ROLLING

In this instance the moisture did not evaporate sufficiently until after two or three days, and it was necessary to continue rolling until there was no longer any movement in the grade.

APPEARANCE OF THE GRADE AFTER LAP-ROLLING

American Autos and Highway Equipment in South Africa

By King Hamilton Grayson*

Nearly every farmer of importance in South Africa owns an automobile to provide rapid transport to the cities for himself, family, and products. In the South African Union, a federation of spacious colonies, the capitals lie at an average of 1,000 miles from each other. Motor transportation has therefore become one of the essentials of the country, for pleasure as well as for business. These conditions call for both through and local highways in increasing mileage. The topography of the county, characterized by great stretches of level plateaus and bordered by alluring mountain ranges, is favorable to construction of highways at reasonable cost.

Motor cars were first introduced in South Africa in 1896 but not until 1906 did they become popular. The following table shows the importations of motor cars by that British colony during the more recent years.

MOTOR IMPORTS IN SOUTH AFRICA

Year	*American*	*British*	*Canadian**	*Others*	*Total Imports*
1919	4,088	87	1,576	1	5,752
1920	7,364	296	2,354	34	10,048
1924	7,181	722	5,078	395	13,376
1925	10,560	1,613	5,424	1,699	18,396
1926	12,813	1,444	2,329	1,473	18,059

*The Canadian imports were mostly Ford cars from Canadian plant.

Several of the American automobile manufacturers have constructed their own assembling plants in Port Elizabeth, which has aided greatly toward popularizing motor cars and creating new highways.

Concrete, macademized and gravel highways are being extended rapidly. The Great Northern trunk road from Capetown to Mairobi is a 4,000-mile boulevard on which traffic has become so heavy that the several governments along its line have been forced to make great improvements. Nearly every village not immediately adjoining a railroad now has motor transportation service; the mail is generally carried by motor cars; and many journeys can be made more quickly and pleasurably by motor bus than by express train. Such trips as that from Johannesburg to Durban, a distance of 418 miles, or from Port Elizabeth to Capetown, can now be made by motor in approximately one-third the time required by mail train. All important towns have large and well equipped garages and many motor lines have been established by the railroads themselves. In the larger cities, buses have become real competitors for street traffic. The officials of the commonwealth realize that South Africa is destined to become a most interesting and popular spot for tourists and hunters and are rapidly extending and improving the highways to prepare for same. Motor roads were doubled in length in 1926 and 1927, and 7,000 miles of modern improved highways are to be added during 1929. Railroads maintain motor service now over a total of 17,000 miles.

American road-making equipment as well as American automobiles have played their share in this development. The following table illustrates the imports of American road-making machinery by South Africa in the most recent years:

IMPORTS OF AMERICAN ROAD-MAKING MACHINERY INTO SOUTH AFRICA.

Type of Machine	*Number*	*Value, Dollars*	*Year*
Road rollers	369	$ 3,836	1922
	1	2,500	1926
Concrete mixers	11	16,013	1922
	10	6,854	1923
	35	13,444	1924
	24	12,884	1925
	55	31,876	1926
	76	25,111	1927
Power shovels	1	7,130	1922
	1	22,475	1923
	2	53,560	1924
	2	6,300	1925
	1	2,875	1926
	1	8,685	1927
	lbs.		
Other road machinery	67,435	8,312	1923
	136,438	15,254	1924
	179,376	16,484	1925
	288,481	36,267	1926
	421,725	41,764	1927

Motor Imports Into South Africa From U. S.

Type of Machine	*Number*	*Value Dollars*	*Year*
Trucks and Buses, 1 ton or less	25	$ 23,996	1922
	68	59,636	1923
	131	100,833	1924
	0	0	1925
	0	0	1926
	2,173	1,100,902	1927
1 ton			
Class B	143	86,204	1925
Class A	114	119,024	1925
Class B	857	432,702	1926
Class A	45	45,477	1926
1 ton to 2.5 tons	25	35,869	1922
	33	43,345	1923
	89	119,258	1924
	250	323,892	1925
	352	418,913	1926
	883	1,011,413	1927
Over 2.5 tons	27	69,572	1922
	2	5,980	1923
	6	21,244	1924
	18	39,345	1925
	39	121,283	1926
	36	109,599	1927
Automobiles Valued at $500	1,018	479,790	1924
	1,621	745,407	1925
	4,052	1,692,464	1926
	4,875	1,903,278	1927
Valued at $800	681	483,076	1922
Valued at $500 to $800	1,170	835,247	1923
	3,201	2,322,970	1924
	3,748	2,812,801	1925
	4,380	3,123,114	1926
	3,404	2,062,261	1927
Val'd. at $800 to $2,000	1,343	1,331,544	1922
	3,054	2,995,165	1923
	0	0	1924
	6,600	7,251,473	1925
	6,228	6,835,672	1926
	9,453	8,638,320	1927
Valued at over $2,000	19	54,935	1922
	22	57,672	1923
	34	93,631	1924
	21	52,938	1925
	19	51,952	1926
	148	307,046	1927

*Consulting research engineer, San Francisco

European road making equipment has been imported to a large extent, due in many instances to the interchange of foreign trade, but it seems certain that, were the American manufacturers of road machinery to lend their cooperation toward greater sales of native South African products in the United States, greater imports of our road machinery would follow. The extent of road building proposed throughout Africa would seem to justify American manufacturers of equipment and machinery in studying the possibility for branch plants in that country. There are still enormous areas to be opened up by highways, and the motor car and truck may be said to be a greater necessity in that section of the world than in America. It enables many of the natural handicaps in the way of insects, disease and hardships to be overcome and tends toward a greater development perhaps than Africa could possibly know otherwise.

Care and Operation of Road Maintenance Equipment

Systematizing work, including shop and field repairs and maintenance. Thorough inspection weekly. Grease, oil and tighten

By J. F. Coleman*

An enormous amount of money has been invested by states and counties in highway maintenance equipment, but there seems to be no general appreciation of the fact that the value of this equipment should be conserved by systematized use and care. Although equipment of all kinds is becoming cheaper, it also is being made of better material and is more scientifically constructed than formerly, is more easily operated and more conveniently cared for; but it would appear that indolence and neglect in care and operation seem to have kept pace with advance in construction, and the useful and economical life of the apparatus is nowhere near as great as it should be.

There are three principal ways of practicing economy in relation to highway maintenance equipment: First, in its purchase; second, by reducing the frequency of necessary overhauling; and third, by lengthening the life before scrapping becomes desirable.

To realize the first, an intelligent and efficient purchasing agent or department is the best medium. Such agents should buy standardized equipment, or as nearly so as healthful competition will permit, so as to enjoy the lower prices that volume purchases always secure.

The second and third requirements are secured by one and the same methods; i. e., proper care and operation. This necessitates, first, securing of proper operators for the equipment, and then seeing that they are not allowed to fall into slip-shod and haphazard methods.

SYSTEM IN MAINTENANCE

To secure care in operation and upkeep of the equipment by all of the personnel of the maintenance department requires a system — a definite and well-defined policy in the care of the equipment and an organization that will insure its being carried out. There must be a standard to work to and the operators must meet standard requirements. All the force, from the lowest to the highest, should be instructed and trained in properly caring for all kinds of equipment, receiving printed regulations covering the same which state in detail the responsibility of the operator, the standard requirements, and the necessity for carrying them out in the smallest detail. The patrolmen and operators should be furnished with all available literature and information concerning the particular equipment in their charge. The person in general charge should see that these regulations and literature are properly distributed, read and understood, and should be held personally responsible for the selection of men in direct charge of equipment who have the proper character and intelligence to carry out the instructions.

The upkeep of the equipment may be divided into three general classes: that done in the field by the operators themselves; that done by trained mechanics in the field; and major overhauling done in a central shop operated by the state or by one of the major divisions.

SHOP REPAIRS

A state division, covering say about 800 miles of varying types of roads to serve an area of about 7,000 square miles, will have practically all kinds of maintenance equipment to look after—tractors, trucks, graders, rollers, cranes, asphalt equipment, etc., much of which is too large and cumbersome to move to the division shop and must be repaired in the field, or in the case of major overhauling, sent to the state shop. The larger and more expensive machinery required for such overhauling will be located at the central shop.

For overhauling light trucks and non-motorized equipment such as graders, heating kettlers, wheelers, etc., also for welding, blacksmithing and central storage of parts and equipment, a division shop is of prime necessity. It will also be headquarters for the mechanics who make field repairs; also an office for issuing instructions and receiving information concerning condition of equipment in the field.

This shop should be equipped with the following as a minimum; a burning-in stand (for light motors); a two-spindle motor-driven drill press; an air compressor; an emery wheel and brush (motor-driven); a paint spraying outfit; a cylinder hone (motor-driven); an electric drill; a blacksmith forge and anvil; also all necessary small tools and equipment. The shop should be well located, lighted and ventilated. A small office for making out reports, attending to correspondence, ordering parts and keeping forms and literature, should be built inside the shop proper. A room for keeping spare parts should be kept locked. There should be adequate shelter to take care of all equipment brought to the shop. Proper sanitation and toilet conveniences should be provided and the shop should be kept as clean and orderly as possible.

Even small counties with two or three tractors and a similar number of trucks or other equipment should have a trained mechanic and a small shop. The mechanic might be used on other routine work, but there are few counties in which all his time could not profit-

*Maintenance Engineer, State Highway Board of Georgia.

ably be used in actual work, instruction and inspection of equipment.

Upkeep of valuable equipment should never be left solely to the ordinary operator. This cannot be emphasized too strongly.

Patrolmen, even if qualified to make field repairs, have too many other duties to make it desirable for them to do so, and the ordinary operator is not competent. This is a specialist job and a trained mechanic is the only one who should be allowed to attempt repairs. He, with as many assistants and helpers as required, with headquarters at the division shop should ride through the division at all times and, when not busy making repairs, should inspect carefully each piece of equipment found on the patrol section, advising and instructing the operators and patrolmen in detail as to its care and operation.

FIELD REPAIRS

The patrolman should select as operators of the equipment the best men obtainable for the salary paid. Where possible, each piece of equipment should be operated by the same man at all times, as this will allow him to become familiar with his equipment and also permit more definite placing of responsibility.

The patrolman should keep the mechanics informed of anything wrong and of new parts needed, so that repairs can be kept up and new parts ordered at once. He should not allow minor troubles to develop into serious ones. A worn or broken part throws additional strain on some other part, and if not repaired or replaced, is apt to cause breakage or undue wear.

FIELD MAINTENANCE

When equipment is brought in from the work, the operator should go over it immediately and prepare it so that it will be ready for use next time, greasing, changing oil, etc. This will avoid loss of time when starting out and also permit discovery of broken parts or needed adjustments in time to have the same attended to before the equipment is needed again.

This casual attention just before and after using the equipment is not sufficient, however, to keep it in the best of shape. There should be a regularly appointed time for its inspection. A half day each week should be set aside for a thorough going over of each piece of equipment. Saturday afternoon could be set aside for this purpose, as the equipment could be brought to the section headquarters more conveniently on that day. This inspection should not consist of a mere cleaning and polishing of the most easily accessible parts nor should it be looked on as a get-together for a half day's chat and story telling, but every piece of equipment should be gone over thoroughly and all necessary work done carefully. All adjustments and connections should be checked and examined. Each piece should be cleaned, greased, and oiled; points that should be brought to the mechanic's attention noted and a list made of parts needed. The patrolman should be present to assist and direct this work. If for any reason the performance of this work on the day designated is interfered with, the very next available day should be used.

Neither operator nor patrolman should be permitted to attempt repairs which they do not thoroughly understand and in no case should they be allowed to make major repairs. The division mechanic should be called in for these; he has more suitable tools and can do the work better in less time, leaving the patrolman to attend to his regular duties.

Oil should be changed and greasing done on the basis of the hours or miles worked and not by the time elapsed since it was done last, making due allowance for the severity of the work done and the condition of the roads travelled. The use of the best obtainable grade of oils and greases will save a large amount of labor, time and cost in the long run.

Use only clean water in the radiators; a clogged cooling system not only cuts down the volume of water but tends to hold more heat and prevent free circulation; which in turn means a breaking down of the oils in the crank case, consequent friction in the motor, unsatisfactory ignition of fuel, greater power loss and general unsatisfactory service. The water should be drained out at least twice a month, circulating it freely while draining so as to carry out scale, rust, and sediment. At least twice a year some approved brand of radiator cleaner should be run through the cooling system, effectively carrying out all deposits, or the radiator can be taken off and boiled in some cleaning solution.

All equipment should be kept well painted a standard color, preferably a neutral shade. Where a portable spray is not available and the equipment can not conveniently be moved to where one is available, the painting can be done by the regular maintenance crew. Painting requires little time and goes far towards preserving the equipment as well as improving its appearance.

Before painting, the equipment should be thoroughly washed, scraped and cleaned. It should be painted all over; the parts hardest to get at will probably be the ones needing it most.

Equipment should not be left in the open for a long period. When necessary to leave it out for any length of time it should be covered. If it is motorized equipment, the motor should always be protected immediately.

To equalize wear on the crawler equipment of tractors, make every other trip on the left hand side of the road. Also this will conform to proper methods of machining.

Do not attach a grader or drag to the rear axle of another grader, as this may result in a bent axle. Rather, fasten the rear grader or drag by means of a long steel rope passing under the rear axle of the front machine to the tractor; holding it in place under the rear axle by a clevis and ring or a loop of another rope. If it cannot be hitched to the tractor, pass the rope under rear axle and fasten it to the frame of the front grader.

Do not overload any equipment beyond what it is supposed to carry. If you do, you will find in the long run that it is actually doing less work rather than more.

Time lost in the field while a puncture is being repaired or the half day that may be lost while a blowout is being repaired or casing replaced results in the loss of time not only of the driver and of the truck, but often of whatever crew may be on the truck or waiting for it. Each truck should carry a spare casing inflated and on the rim ready for use;

and if it uses two sizes, a spare of each size should be carried. Spares should be interchanged with tires on the wheels if carried for any considerable length of time without use. The air pressure in the tires should be maintained, by weekly inspection, at the pressure recommended by the manufacturer. It is beneficial to change them from left to right at intervals, being careful not to reverse them as to direction of roll. Solid tires should be replaced when they reach a thickness of less than one inch. Wheels should be checked frequently to see that they are in line, and adjusted if they are not.

There are hundreds of other details which there is not space here to mention. The attitude should be one of watchfulness, and the slogan: "Grease, oil and tighten; tighten, grease, and oil."

Low-Cost Type Roads in Caddo Parish, Louisiana

History of the stage or progressive construction of several roads in that parish on the "Pay as You Go" plan

By J. T. Bullen*

The general public is inclined to make an insistent demand for the highest class of paved roads everywhere. That sounds fine to the farmer and to all classes, until one begins to look for the funds to bring about that end. If we are to have paved roads everywhere we shall have to pay for them—there is no way around that. When one stops to think that notwithstanding the enormous sums spent for highways in this country, only about eighteen per cent of our roads have been surfaced, leaving eighty-two per cent yet to be improved and surfaced, the immediate question is, where shall we get the funds for surfacing such a large mileage with even low-cost types?

It must be clear to anyone who gives this problem any thought, that the agricultural cross-road with fifty to five hundred vehicles per day does not require the same type of surfacing as does a main highway, with from 3,000 to 30,000 vehicles per day; and since various low-cost types will adequately and acceptably accommodate the lighter travelled roads, it is suicidal in a financial way to build expensive paved roads where the low-cost type will serve for many years to come.

There is a very definite place for the paved road and an equally definite place for the low-cost type. There are doubtless counties, and even states, where highway work has lagged far behind industrial development and the present traffic on the highways demands, near cities, not progressive construction, but high class pavements from the very beginning of the improvement program. There are, also, counties, and some states, which still require but few paved roads and should begin their program of construction with the thoroughly modern idea of stage, or progressive, construction.

First, grading and draining the most important roads; then gravelling, or macadamizing them; then oiling them to protect macadam from abrasion and ravelling; and then, as traffic grows, widening the surface and adding bituminous surfaces of moderate cost; and finally adding bituminous paving. By this progressive or stage method the road system grows rapidly, gives quick relief to a large area and, as traffic develops, the system is made to develop with it, conserving the original investment in lower types. The interest on the saving in first cost per mile goes a long way toward extending the system and more taxpayers are accommodated adequately than could be accommodated if high-priced paving were resorted to for all roads regardless of traffic.

In the following article will be described briefly the highway system of Caddo Parish, Louisiana, at Shreveport, which is an exemplification of the stage, or progressive, method of construction.

Caddo Parish, (or Caddo County, as it would be called in other states), was entirely without highways in 1911, unless one counts the impassable mud roads and one mile of gravel at the city limits of the city of Shreveport. At that time there were few if any automobiles in the parish and no trucks. In 1912 the people voted a five-mill property tax, to run for five years, with which to build roads and bridges and committed the police jury (same as county commission in other states) to the policy of building five main radiating roads from the city of Shreveport. In 1912 the work was begun.

The 5-mill tax brought in about $125,000 the first year. The same tax was again voted at the expiration of the five years and has been voted four times in succession.

The problem before us in 1912 was how to get a large mileage of roads sufficiently substantial to get the people out of the mud and do it quickly. The roads were graded generally twenty-four feet wide, exclusive of ditches, and surfaced sixteen feet wide with gravel or macadam. For the first five years the average cost per mile, including grading, concrete culverts, and wooden bridges was $6500 per mile. Before the five-mill tax expired, traffic was increasing in leaps and bounds, especially automobile and truck traffic.

The greater part of our roads were surfaced with a sand-clay gravel having from fifty to sixty per cent of rounded pebbles retained on a No. 10 riddle and running up to two inches in diameter, and the balance of the aggregate composed of a good mixture of red clay and sand, and the above-mentioned growth of automobile and truck traffic made it apparent that the wear and tear on a gravel or macadam road, added to the dust nuisance, could not be tolerated.

In this dilemma we resorted to oil surfacing. The gravel roads were patched and bladed to a smooth surface, thoroughly swept with horse-drawn rotary and hand brooms, covered with one-third to one-half gallon of asphaltic oil per square yard, then covered with the same material that had been swept from the surface and turned over to traffic. In a week or ten days it was ironed out smooth and dustless and presented a surface very acceptable to all kinds of traffic. The surface was easy-riding, easy on the eyes, non-slippery, and with no loose gravel or grit to wear either horse shoes or automobile tires.

Our macadam roads, built of soft limestone, or marble, were given the same oil surfacing, with even better results than on the gravel.

*Parish engineer, Caddo Parish, Louisiana.

From time to time we have had to re-oil these surfaces and we have gradually widened the surfacing to eighteen and twenty feet. When traffic increased still further, we put six inches of macadam on top of the old gravel and oiled the new macadam. When traffic increased to a point too heavy for oiled macadam, we resorted to a two-inch pavement of asphaltic concrete, amiesite, sheet asphalt, or other type of real pavement, using the old macadam generally as a base for the new pavement, thus conserving the original investment.

In some places where gravel had not been resurfaced with macadam, we plowed up the old gravel and used it for shoulder material and laid concrete pavement.

In this day and time, an engineer will generally use a pavement type for main highways leading into or between large cities, (automobile and truck traffic generally justifies such a course), and the low-cost type road surfaces for the cross roads and general agricultural feeder roads. And for probably all time to come there will be a place for the low-cost type of roads.

PHOTOGRAPH NO. 1—STATE HIGHWAY NO 8, SECTION "R," BETWEEN SHREVEPORT AND TEXARKANA

This road was surfaced in 1921 and 1922 with six inches of soft limestone with 25 per cent of quarry dirt mixed with it, and in 1923 from three to four inches of washed gravel and binding clay added.

In August 1923 first application light oil.

In September 1923 second application light oil.

In 1927 and 1928, widened from 14 ft. to 20 ft. with limestone macadam and resurfaced 20 ft. wide with 4-inch depth macadam, using about 2500 cu. yds. of rock per mile.

In 1928, two applications of oil, about .4425 gal. per square yard, including both applications.

Maintenance 1923 and 1924 was approximately $1000 for the two years.

Maintenance 1925	$278.00 per mile
Maintenance 1926	265.24 per mile
Maintenance 1927	568.10 per mile
Maintenance 1928	89.57 per mile
Maintenance 1929 to April 8th	24.64 per mile

We have had the use of a surfaced road from first of 1923 to date—six years—and road is in fine shape, better by far than at anytime during the six-year period and is good for at least eight years more, with annual maintenance of about $500 per mile, including re-oiling, and at end of that period it will be in excellent condition to use as a base for two inches of bituminous pavement, if traffic shall have increased sufficiently to demand pavement.

Including first cost and maintenance, the $138,500 spent in 1927 and 1928 in widening to 20 ft. and the oiling and re-oiling, this section of road has cost $23,840 per mile. A paved road in 1922 at the then prevailing prices would have cost $30,000 or more, and adding to that the maintenance charges for six years plus interest charges on high first cost, you will see that the progressive low-type construction was justified in this case and the photograph shows that it is in excellent condition.

The white on edges is the sand cover left from covering oil and whipped to the sides by passing cars.

There have been some excellent detailed reports made on the subject of low-cost type roads in the last few years, such as C. N. Conner's report in the proceedings of the Highway Research Board; the fifty-six pages or more so ably presented by E. W. James in the pamphlet published by the Highway Education Board, and many others; so that it would be out of place in an article of this kind for me to attempt to go into detail regarding the various low-cost types. However, I am submitting, with this article, photographs of Caddo Parish highways showing their condition after years of what is frequently termed the stage, or progressive, method of road building. This presentation, in pictures, of the roads today, with a brief history of them and some cost and maintenance records may prove enlightening to those interested in low-cost types.

The Parish has been building and maintaining highways for sixteen years on a "Pay as you go"

PHOTOGRAPH NO. 2—SHREVE ISLAND ROAD

Surfaced 18 ft. wide with oyster shells April 1927, at a cost of $6,070.73 per mile.

Oiled in October 1927 using .14 gal. of liquid asphalt per square yard for priming coat and following that with .2039 gal. of 250-300 penetration asphaltic oil. The priming coat applied cold; the heavier oil applied hot.

The oiling cost $.0683 per square yard.

Maintenace in 1928	$331.03 per mile
Maintenance to April 1929	14.10 per mile

Photograph taken April, 1929.

PHOTOGRAPH NO. 3—SEVENTIETH STREET ROAD

Surfaced fall of 1925, 18 ft. wide, with 8 inches loose depth of gravel at cost of $5,353.17 per mile.

Surface maintenance for 1925—$31.00 per mile.

Oiled in May, 1926, using .45 gal. of 250-300 penetration oil at cost of $.0706 per square yard.

Maintenance 1926	$568.83 per mile
Maintenance 1927	255.84 per mile
Maintenance 1928	150.96 per mile
Maintenance 1929 to date of photo	23.18 per mile

This is practically a suburban street and takes quite a lot of traffic.

plan and has no bonded indebtedness. A levee system ninety miles in length, and approximately 125 miles of drainage canals (one canal with a bottom width of 140 feet) and a court house costing a million and a quarter; all these things have been accomplished and no outstanding bonds.

Our road system consists of 21 miles of concrete; 47 miles of bituminous pavements; 43.7 miles of oil surfaced macadam; 135 miles of gravel (nearly all of which is oil surfaced); 116 miles of graded and drained roads, and approximately 250 miles of unimproved roads except slight effort at draining; totaling:—

68 miles of pavement
250 miles of gravel and macadam (oil surfaced)
116 miles of well graded and drained roads
250 miles unimproved, except to very slight extent

684 total mileage of parish roads.

PHOTOGRAPH NO. 4—STATE HIGHWAY NO. 8, SECTION "L"

Was surfaced in 1914 and 1915 using old railroad embankment for grade. Old gravel ballast spread 16 ft. wide and four inches of pit run sand-clay gravel added as a binder.

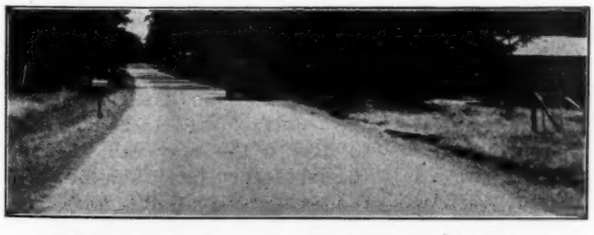
It was oiled in 1919, re-oiled in 1920, and a concrete curb 8 inches at top, 12 inches at base and 9 inches deep, was put down in spring of 1924 and an average of six inches of macadam filled in between curbs over old gravel.

It was oiled in February 1925 with Standard Binder "A" and covered with Joplin, Missouri chatts at a cost of $998.45 per mile, or a trifle over nine cents per square yard.

Maintenance 1925	$718.10 per mile
Maintenance 1926	107.55 per mile
Maintenance 1927	365.47 per mile
Maintenance 1928	581.43 per mile

However, the heavy maintenance shown here was due to a section about two hundred yards in length that developed springs and caused an unusual amount of repairs; in fact, a lot of macadam had to be taken up and French drains put in. The actual maintenance on balance of the section has amounted to not exceeding $150 per annum per mile, or even less.

This is a through state road and carries heavy traffic, and photograph taken in April, 1929, is typical of condition of the whole section.



PHOTOGRAPH NO. 5—STATE HIGHWAY NO. 8

This is a 2-inch asphaltic concrete pavement 18 ft. wide, put down in October, 1926 on a macadam base which was laid over an old gravel road.

There was no maintenance in 1927 and 1928 on this section of asphaltic concrete, though it carries a heavy traffic between Shreveport and oil fields and through traffic to Texas and Arkansas.

Photograph taken April, 1929.

PHOTOGRAPH NO. 6—HOLLYWOOD AVENUE

A suburban road carrying very heavy cross-town traffic. Included in the traffic has been a large number of trucks hauling very heavy loads of logs.

It was first surfaced with Winnfield marble in the fall and winter of 1925 and 1926, so it is a little over three years old.

It is surfaced 18 ft. wide with 9 in. depth macadam measured loose and cost $12,690 per mile. Stone and freight cost $3.38 per cubic yard f.o.b. cars.

It was oiled April, 1926 with 250 penetration oil, using .4194 gal. per square yard, covered with sand and Joplin Missouri chatts, at a cost of nine cents per square yard.

Surface maintenance 1926	was	$170.60 per mile
Surface maintenance 1927	was	152.93 per mile
Surface maintenance 1928	was	13.54 per mile
Surface maintenance 1929	was	30.56 to date of photo

The photograph taken in April, 1929 shows its excellent surface.

Street Cleaning and Refuse Disposal at Toronto.

The report for last year shows increased use of motor equipment and the trailer system of collection

The organization and functioning of the department of street cleaning of Toronto, Ontario, was described at some length in the May, 1927, issue of PUBLIC WORKS. The report of Superintendent George W. Dies for the year 1928 gives the corresponding figures for that year, which offers an opportunity for comparison and for noting progress which has been made along any lines. The general organization and functions were the same as in 1926.

We note that the average number of men engaged daily in the various services of the department have increased from 990 in 1926 to 1,023 in 1928; that the vehicles used in refuse collection have decreased from 525 to 498, while the number of men engaged continuously at the refuse disposal plant have increased from 95 to 102.

The amount of work has increased approximately in proportion to the increase in number of men; but it would appear that the vehicles now employed are of greater capacity or are more effectively used than

those in the service two years ago. Probably the refuse collection service is chiefly responsible for this. The department in 1919 inaugurated the trailer system and has been gradually motorizing the refuse collection service and in 1928 had 40 motor trucks in service. The hauls required on account of the scarcity of available dumping grounds have necessarily increased in length, but the use of the trailer system has reduced the cost of hauling. In 1928 there were 107 trailers in operation as compared to 87 two years previous. Each trailer has a capcity of six yards and carries approximately 3,000 pounds. It is horse-drawn while being loaded, and is then left at a designated place to be picked up later by a tractor or truck. These trailers are hauled in trains of three or four to the disposal plant, while the two-ton trucks placed in operation within the last two years haul one trailer when necessary. The city still hires 80 private vehicles for collection, but hopes to increase the motor service until it will be unnecessary to do any hiring.

Superintendent Dies believes that the patrol system is the most suitable method of cleaning the downtown business streets and the main business thoroughfares. Each patrolman has a definite area to patrol, averaging 3 miles of streets or approximately 40,000 square yards (two years ago it was 3.4 miles or approximately 50,000 square yards); which area he covers from one to eight times a day. Each patrolman is provided with a paper picking bag, a push cart, broom, scraper and shovel. He covers his beat on the first round each morning with a paper bag, removing all loose paper which may be on the boulevards, walks, or roadways. He then commences his rounds, removing all street dirt, which he deposits in the push cart. As the cans are filled they are left at designated points and are picked up later by a truck.

The remaining sections of the city are under the squad system, the men working in pairs, one on each side of the roadway, followed by a pick-up vehicle. This system is carried out in residential and outlying sections. The 190 patrolmen in service in 1928 received a weekly wage of $28.80. The cost of maintenance per thousand square yards for the season for hand-broom sweeping was $36.53, or $2.63 per cubic yard of sweepings collected and removed. The average number of sweepings received by the streets during the season was 90. The cost of sweeping per thousand square yards of sweeping done, including collecting and removing, was 40.7c.

The city operates two electric flushers at night, flushing the downtown section, each street receiving a flushing on alternate nights. The trucks are operated one behind the other, as this method gives the best result owing to the fact that it takes a few minutes for the dirt to become saturated, the first flusher doing the saturating, when the second flusher washes it readily into the gutter. On this account, should a light rain occur before or during flushing, the flushers are operated singly, the rain doing the saturating. The total cost of flushing was 13.8c per thousand square yards, the same as in 1927 and one tenth cent less than in 1926.

During 1928, 53,961 tons of refuse were disposed of at the Don destructor at a total cost of $1.46 per ton or 2.4 man-hours of labor per ton; as compared with 52,081 tons, a total cost of $1.52 and 2.5 man hours in 1926. These total unit costs are based on the total operating cost of the plant for the year, which includes tipping floor man, charging men, stokers, ash-run men, removal of ash residue, supervision, weigh scale clerk, privileges accorded employees (consisting of a half-day off per week with pay, statutory holidays, two weeks' holidays, and one month sick pay), and also supplies and repairs to plant and the building. The total cost per ton is the same as in 1927 and 6 cents less than in 1926. Since 1918 the cost has varied from a minimum of $1.40 to a maximum of $1.58.

The Wellington destructor disposed of 80,471 tons at a labor cost of $1.00 and a total cost of $1.12. The Island incinerator destroyed 684 tons at a labor cost of $1.02 and a total cost of $1.39 per ton.

Three-Inch Wire-Cut Lug Brick Reinstated

In March, 1925, the Committee on Vitrified Paving Brick of the Division of Simplified Practice of the Bureau of Standards, eliminated from the list of recognized standard sizes of brick the 3x3½x8½ wire-cut lug, leaving only the 4x3½x8½ size of that type of brick. During the past three years shipments of the 3x3½x8½ size have increased until it represents 14.5 percent of the total paving brick used in 1928; because of which the committee has recommended to the industry that it be reinstated as a standard size. This gives six standard sizes, the 2½-inch plain wire-cut having been reinstated in 1927.

If the 3x3½x8½-inch size be included as standard, the degree of adherence to the recommended standards becomes 84.6 percent; it having been 70.1 percent with this size excluded.

Contractors Save by Using Cement-Water Ratio

The cement-water ratio was used recently by the Fisher-Devore Construction Company, Cincinnati, in constructing a four-story warehouse in that city, this being required by the specifications, which were the standard specifications approved by the Portland Cement Association and the American Concrete Institute.

The contractor states that not only was there no need for extra equipment on account of using this method, but a considerable saving was made on materials, besides producing a concrete whose average strength was above that specified; the concrete having been designed for 2500 pounds per square inch, while test cylinders averaged 2800 throughout the entire job.

Since this was the first project in Cincinnati to be built under a strength specification based on the cement-water ratio, the contractors retained a local testing laboratory to design the mix and make all tests. Accordingly the laboratory took samples of the several varieties of aggregate available, making a sieve analysis of each, and laid out a mix based upon the weight of all ingredients. The laboratory also tested the samples of each day's concrete for compressive strength and examined each batch of aggregate to see that it conformed to the original specifications, and also tested it for moisture. However, after the proper proportions by weight and the amount of water to be used had been determined, the general carrying out of the design was left to the

mixer-operator who became so well acquainted with the type of concrete necessary as to be able to tell by looking at the mix whether any change was needed in the water content due to moisture changes in the aggregate.

Slump tests were made also at regular intervals to check up on the judgment of the operator. The excellent result obtained by leaving so much to the judgment of the superintendent and his mixer-operator is attributed by Mr. Devore, of the contracting firm, to the fact that all of his foremen, superintendents, and mixer-men were in attendance at the night schools in concrete conducted by the Portland Cement Association, and through these schools became acquainted with the general requirements for making good concrete.

Mr. Devore states that, in his opinion, the contractor can save money in making concrete if he will conscientiously apply the knowledge available for making concrete according to strength specifications rather than to the old proportion specifications. In Cincinnati, particularly, where gravel and rock costs are above the average, the requirements of ordinary strength call for an over-sanding condition, permitting a saving in the amount of coarse aggregate as well as in the amount of cement used per cubic yard of concrete. On this job there was a considerable saving in both items, which more than balanced the extra cost entailed by the laboratory expenses. Mr. Devore believes that, with the experience gained on this project, his firm will be in a position to make an even greater saving on future contracts, besides cutting down the cost of designing the mix and other work which was done by the laboratory but which can now be done by the contractors' own forces.

The above description is condensed from an article in "The American Contractor."

Crickets Trouble Department of Street Cleaning.

The annual report of Geo. W. Dies, street commissioner of Toronto, Ontario, contains an unusual item concerning a cricket plague. It seems that during the summer of last year the house cricket caused a great deal of trouble in the vicinity of Fairmount Park and many citizens attributed the presence of these pests to local refuse dumps, although only three of the several dozen dumps maintained by the department were infested with crickets. However, the department did its best to exterminate them from the three dumps which were so infested.

This offered a unique problem, and one with considerable difficulty because of the great rapidity with which the eggs hatched and the young developed. The most effective method was the use of quick lime. Unslaked lime was spread over the entire dump 4 to 6 inches deep, working from the outer edges towards the center in order to retain the crickets on the dump. The lime was slaked as it was spread, and intense heat created by the chemical reaction completely destroyed all insect life that it came in contact with.

The crickets had, however, infested garages and residences in the proximity of the fills, creating a great nuisance by their incessant singing and destructive habits. The extermination of the crickets within the buildings present a new aspect to the problem. Pyrethrum powder was distributed by means of a powder gun in all cracks around cellar windows, sills and doorsteps, and in some instances was placed in the corners and behind base boards within the houses. This powder proved very effective. A solution composed of one part oil of cedar and nine parts kerosene was used in conjunction with the pyrethrum powder and was distributed by means of a spraying machine. This solution was used around the outer parts of the houses and in the cellars where crickets might gain entrance. It was necessary to continue this extermination work during the entire summer months and it was only when the cool weather set in that the crickets were entirely eradicated.

The fills in which these developed were being made as an improvement to Fairmount Park, and consisted of ashes, rubbish, and the ash residue from one of the refuse destructors. This filling, however, has been completed and has been covered entirely with clean earth, and as far as this dump is concerned there is no danger of a recurrence of the cricket nuisance.

Refuse Collection and Street Cleaning in Cincinnati

The Department of Waste Collection in Cincinnati has charge of the flushing of alleys, removing of ashes, cleaning of catchbasins, operation and maintenance of city dumps, collection and removal of rubbish, cleaning of sewers and of streets, and supervision of the collection of garbage, which is performed by a private company under contract.

The department serves about 136,568 families who live in approximately 80,600 dwellings. These families live on about 958 miles of streets and roads, of which 583 miles are improved.

During 1928 345,580 cubic yards of ashes and rubbish was removed at a cost of $254,731. During the year progress was made towards motorization of the equipment used in removing ashes and rubbish, an additional trailer unit being installed in the eastern part of the city in June; also an electric tractor has been experimented with and is proving quite satisfactory. Cincinnati is believed to be the first city of its size to use a modern electric tractor and finds it an improvement over gasoline vehicles.

The most notable improvement in the trailerized territory is the collection of ashes and rubbish from the kitchen door instead of the property line. Not only has the service been improved by the use of the trailer unit, but costs have been lowered, the collection for 1928 being $7.39 per cubic yard against $8.13 in 1927. Since the use of trucks and trailer units, all of the so-called residential dumps have been abandoned, resulting in greater comfort and peace of mind to householders. Dumping is now concentrated on a few major dumps, most of which are on city property, the filling of which will enhance the value of the property.

A great improvement has been made during the past year with regard to the use of proper containers. Work is being done along this line constantly by reminding the householders that an ordinance requires the placing of rubbish in metal cans with tight fitting lids.

The actual street cleaning operations are closely bound up with the ash and rubbish collection, although the costs are kept separate. All streets in the downtown business area are cleaned at least once a day, most of the work being done early in the morning be-

fore there is much traffic on the street by squads of men having certain areas to cover. Patrolmen are maintained on the most important streets to sweep up refuse and collect it in cans which they wheel around with them. Other districts are cleaned once or twice a week by men who work in gangs.

Street cleaning operations have been aided greatly by the use of motor apparatus, although on account of traffic conditions it may be used to advantage only at night. Except in cold weather, power flushers are used on improved streets and main highways. The business section of the city is flushed every night and the main arterial highways are flushed once or twice a week. Four flushers were in operation last year and an additional one was to be placed in operation this spring. Last year 135,796 squares were flushed at a cost of $8,603. Two machine sweepers also operated in the summer time, these doing from eight to ten times the work of hand sweeping, although they can be used only on smooth pavements and, even when operated at night, are confronted with difficulties in the way of parked and moving automobiles. Last year these machines treated 19,152 squares at a cost of $3,381. Market cleaning is taken care of by special squads of men.

Inlets and catchbasins are cleaned systematically throughout the year, the work being so planned that the cleaning crews are continually at work covering all sections of the city, removing refuse from catchbasins, inlets, and main sewers. At the end of 1928 an improved auto eductor was placed in operation and as a result the cleaning costs are far less, and it is estimated that within two years the savings will have paid for the machine.

All garbage in the city is collected by the Union Reduction Company, under a contract, at a cost of $202,500 a year. A field inspector is maintained by the waste collection department, who investigates all complaints of irregularities in the service and sees that collections are made in accordance with the conditions of the contract with the city.

The entire work of the waste collection department exclusive of garbage collection is done at a cost of $1.03 per person per year. The garbage collection and supervision costs 44.8c. per person living in Cincinnati.

Salvaging Waste in Ferndale

The city of Ferndale, Mich., has developed a quite comprehensive system for salvaging municipal waste, especially interesting being its methods of disposing of wastes which present unusual difficulties, including tin cans, automobile bodies, bed springs, and other non-inflammable materials.

The city bought a can baler which presses cans together in bales weighing about 35 to 40 pounds. When a carload of these has been baled they are shipped direct to the smelters to be used for different purposes, one of which is for making window sash weights. A great many bottles are found mixed with the cans and these have to be sorted from the cans before they are baled. It is hoped to solve this nuisance by ordinance in the near future. If the bottles and cans could be kept in separate containers and sorting be eliminated, a larger profit would be made. The city finds a great deal of old aluminum ware and glass among the tin cans, and these materials are sorted out and sold separately, the aluminum bringing more than 10 cents per pound.

Also a market has been found for all glassware in carload lots. There does not seem to be much profit possible on glass, but it offers a means of disposing of the glass, removing a problem which had formerly given much trouble.

Abandoned automobile bodies are found in all parts of the country, and Ferndale, like other cities, was vexed with the problem of disposing of them. Those having old bodies would ask the city officials what they could do with them, saying that if a place could be found for them they would gladly haul them there. The city brought a pair of shears capable of cutting iron bars up to 3 inches square. The old automobile bodies are hauled into the yard and the fenders and sheet metal work are cut up into 8-inch squares, called busheling. This metal is shipped in carload lots to the smelters to be used for resmelting. The engines are loaded separately and shipped. The rest of the car, such as frame, axles, rods, are cut up into lengths not longer than 30 inches and shipped separately in carload lots. In some cases the brass and babbit metal are removed and sold separately.

From the continuous changing of telephone lines and electric light lines there is a great deal of copper wire wasted, and this is piled up and the insulation burned off and the copper than baled and sold. There is always a ready market for this copper at 10 cents and more per pound.

Merchants have been in the habit of burning papers in the alleys, making a very unsightly nuisance. To eliminate this, the city purchased a paper baler that bales paper into 100 pound bales. It is now collecting all paper from the merchants every day, baling it and shipping direct to the paper mills in carload lots and has found it very profitable.

All concrete that is broken out from different work about the city is hauled to the yard, put through a stone crusher and used in repairing streets.

Ferndale makes the Salvaging Department pay for itself, taking into consideration the saving in cost of hauling effected by placing the salvaging yard within the city limits instead of having to haul the material to a dumping ground outside the city. This saving in hauling, along with the money received from salvaging, gives the city a very nice profit. There is also to be considered the investment that the city would have to make in land for a dumping ground, and a consideration of the unsightliness of such a ground and its menace to the health of the community.

Said Carl H. Peterson, city manager of Ferndale, (from whose paper before Kansas Municipalities this information has been obtained): "In marketing tin cans, paper and iron, one should watch the market very closely. Cans, iron, steel and copper, do not deteriorate, and as there is a wide fluctuation in the market from one year's end to the other, a city should avail itself of plenty of room for storage and sell when the market is best. It is also quite necessary that the city yard be located on railroad frontage because of the importance of convenience for loading in cars. . . . . There is nothing pertaining to municipal waste that cannot be salvaged at a profit if properly cared for."

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The Tunneling Age

This has been called the electric age, the flying age, and various other names to designate the direction in which it seems to have advanced most notably from previous practices; and among these tunneling might well be included.

Railroad tunnels were built more than fifty years ago, at great cost of both time and money. But during the past fifteen or twenty years rapid driving of long tunnels through rock, clay and every variety of soil has become a commonplace proceeding. Last month a set of subway tunnels were "holed through" under the East River, New York City, and the event was given only an inch or two of space on an inside page of the papers. Railroad and vehicular tunnels were operating under the Hudson river at New York before the first bridge over it at that point was even started.

Traffic of human beings and freight no longer monopolize tunnels. Thousands of miles of tunnels are in use for carrying water under mountains and rivers where formerly aqueducts and bridges would have been used. It is necessary only to mention the various tunnels of the Catskill water supply of New York, the Hetch-Hetchy supply of San Francisco, the forty-five miles of tunnels in the long aqueduct connecting Los Angeles with Owens river and numerous others of less length.

In this issue we describe two of the latest waterworks tunnels, thirteen miles of tunnel nearly thirteen feet in diameter to increase the supply of the Metropolitan District of Boston, and twenty miles of seventeen-foot tunnel to increase the capacity of New York's distribution system. It is apparent that engineers who design water works systems must keep themselves informed concerning the possibilities, methods and costs of tunneling as applied to water transportation.

Cellar Drainage in Sanitary Sewers

Probably there are very few systems of pipe sewers which carry only legitimate sanitary sewage, even though this term be held to include all water used in buildings for commercial and manufacturing as well as domestic purposes. It is commonly assumed that the excess flow is ground water entering the sewer through pervious pipe joints, manhole walls, etc.

An engineer in a New Jersey community has (as told on another page) apparently traced a large part of the flow in its sewers to the temporary draining of cellar excavations through house connections, and a less amount to illegal use of such connections permanently for draining the ground under cellars of completed houses. And the town council believed that to prevent the practice would greatly retard the growth of the town, seeing no remedy but the prohibitively expensive one of constructing storm sewers. It is possible that other towns may find in this prac-

tice a partial explanation of large non-sewage flow in their sewers.

Another article in this issue suggests a method of furnishing cellar drainage without using either sanitary or storm sewers. A subdrain considerably larger than the sewer was laid beneath it and keeps the ground water lowered, carrying continuously a flow several times that of the sanitary sewage.

The two articles are unusually interesting and suggestive.

Why Mend the Roof When It Is Not Raining?

"Because of the lowness of our water supply in W——pond, the hydraulic engineers —— &——, were employed to investigate other sources of supply."

"The water in W——pond is now 17½ inches higher than a year ago."

"The report of the hydraulic engineers, too long to print, has been placed in the safe of the water department."

From report for 1928 of the water commissioners of a city of about 15,000 population. Comment seems unnecessary.

Lighting of Columbus Airport

It is expected that Port Columbus, the eastern terminal at Columbus, Ohio, of the Transcontinental Air Transport Line, will be completed by June 1. One of the features of the port is that it is the first one to adopt a new floodlight developed by the General Electric Company, which will have an intensity of three million candlepower and, it is stated, will enable one to read a newspaper without eyestrain at a mile away and within 2500 feet the illumination is sufficient for the pilot to see the nature of the landing surface and quickly and safely make his landing.

This floodlight contains eight high-power incandescent lamps arranged in a row in front of six cylindrical mirrors which spread the light over the field at a low level so as not to blind the pilot. In addition, there will be a 500-watt, 14-inch ceiling light elevated at an angle of 63 degrees, equipped with a ceiling indicator to enable the port authorities to record the ceiling at any time. Each of the larger buildings will be illuminated by four flood lights.

Medical Field Service School

The second special course in Military Sanitation will be given under the direction of Maj. G. C. Dunham at the Medical Field Service School, Carlisle Barracks, Pa., July 8 to 20. This course will deal with the application of approved principles of sanitation to army conditions. It will cover food inspection; waste disposal; housing; water supply procurement, distribution and treatment; mosquito and other insect control; sanitary surveys and orders; camp sites; and field sanitation.

The course is exceedingly practical and affords valuable training not elsewhere available. The first course, last year, under the direction of Major Dunham, was attended by 46 engineers and sanitarians. The attendance this year will be limited to similarly trained men. The course is open to men east of the Mississippi. Applications from qualified men must be made through the Surgeon General of the army, but the number of men who can be trained is limited.

Instruction will be given by Majors Dunham, McDonald, Fox, Willis, Gibson, Taylor and Hardenbergh (assoc. editor of *Public Works*), Lt. Col. Williams, and Captains Blesse and Pollard.

Septic Treatment at Alliance

Alliance, Neb., population about 9,000, treats its sewage in a septic tank, but is finding difficulty in disposing of the effluent without creating a nuisance. L. A. Goines, city manager, in his report for the last six months of 1928, urges that "action be taken by the city towards effecting a permanent disposal in the sand hill region southeast of the city." He considers the most feasible plan to be pumping the septic tank effluent to the top of a hill from which it can flow by gravity onto a sandy section of land.

The cost, for the last half of 1928, of "operation of septic tank and distribution of sewage at city farm," was $902.38. Current for pumping sewage, estimated at 12,000 kw.h., worth $600, was furnished free by the municipal plant. A new transformer and electrical and other equipment cost $185, and painting and cleaning up the caretaker's house $50; a total of $1,737.

Some 1928 Water Works Data

Figures compiled from questionnaires show amounts and kinds of pipe laid as street mains and the principal features of water treatment in the cities reporting.

More than half of the cities replying to our questionnaire this year report treating their water supply, about one-third filtering it; and all but seven of those using any treatment include chlorination. Only ten soften the water.

Most of the filters are rapid sand, but slow sand filters are used by sixteen per cent of those filtering.

Sedimentation basins are used in most of the filter plants and also in six plants that do not filter.

Of the amount of pipe laid last year, the percentage of that smaller than six-inch seems to be higher than usual, although more than half the cities laid no pipe less than six-inch. Some laid nothing but four-inch or smaller. One used two-inch for about a quarter of the mains laid. Where two mains are laid in a street, one may very properly be smaller than six-inch; but pipe of such sizes is of little use for feeding fire hydrants.

Cast Iron Pipe Laid in 1928

City and State	Under 6-inch	6, 8, 10 and 12-inch	Over 12-inch
Alabama:			
Bessemer	8,000	1,500	24,444
Arizona:			
Tucson	5,400	40,000	....
Arkansas:			
Fort Smith	....	4,578	....
California:			
Brawley	1,500	....	....
El Centro	10,200	1,000	....
Hayward	....	5,862	....
Lodi	....	600	....
Long Beach	10,044	117,894	13,163
Red Bluff	....	3,000	....
San Jose	52,438	26,708	3,255
Santa Barbara	9,491	42,749	4,074
Vallejo	1,000	5,000	....
Colorado:			
Greely	4,787	4,394	....
Connecticut:			
Danielson	....	1,700	....
Putnam	....	378	....
Southington	35	6,477	....
Wallingford	....	8,306	....
Willimantic	....	2,500	....
Delaware:			
Wilmington	504	10,750	34
District of Columbia:			
Washington	5,556	140,786	56,530
Florida:			
Naples	5,000	....	....
Orlando	21,000	7,700	....
Tampa	....	60,000	....
Georgia:			
Albany	....	2,900	....
Illinois:			
Danville	....	7,391	....
Lincoln	326	2,073	....
Oak Park	....	13,082	....
Pekin	905	15,474	....
Peru	900	....	....
Quincy	....	21,828	941
Sterling	....	1,500	....
Indiana:			
Columbia City	509	84	....
Elkhart	2,817	12,726	524
Logansport	....	4,000	....
Mishawaka	42	15,626	3,802
Muncie	....	9,700	....
New Albany	....	4,000	....
Peru	....	132,000	6,500
Richmond	254	5,324	....
Iowa:			
Ames	1,750	3,751	....
Burlington	150	7,626	5,776
Hawarden	2,200	....	....
Oskaloosa	3,038	5,673	....
Sioux City	5,952	35,700	....
Kansas:			
Lawrence	2,400	....	....
Kentucky:			
Hazard	1,800	....	....
Louisiana:			
Baton Rouge	102	5,449	....
Mansfield	....	20,000	....
Maine:			
Biddeford (a)	2,993	42,350	....
Portland	....	28,882	....
Maryland:			
Hagerstown	....	4,600	43,600
Salisbury	....	19,200	....
Massachusetts:			
Athol	....	8,127	....
Belmont	....	16,764	....
Brockton	....	11,029	6,074
Cambridge	224	5,842	....
Cherry Valley	....	1,000	....
Clinton	....	1,684	....
Danvers	....	4,403	....
Framingham	171	....	....
Haverhill	496	2,985	1,203
Melrose	....	10,500	....
Milton	400	14,000	....
New Bedford	....	3,458	2,561
Northampton	1,519	13,202	....
Oxford	4,354	5,924	....
Revere	....	3,190	....
Saugus	....	10,540	....
Spencer	90	....	....
So. Hadley Falls	....	3,500	....
Springfield	551	17,558	....
Weymouth	784	15,582	....
Winthrop	....	4,439	....
Woburn	....	10,400	....
Michigan:			
Coldwater	....	1,565	....
Manistee	6 miles	8 miles	5,000
Marquette	1,093	693	....
Mt. Clemens	....	14,473	8,000
Sturgis	....	3,400	....
Traverse City	....	1,000	....
Minnesota:			
International Falls	5,524	3,736	5,710
Minneapolis	....	76,292	5,887
Rochester	7,400	9,700	....
Mississippi:			
Clarksdale	....	5,000	....
Jackson	....	12,000	....
Missouri:			
Jefferson City	....	2,000	....
Moberly	....	5,507	....
Montana:			
Billings	11	5,222	3,643
Bozeman	450	1,450	7,500
Great Falls	824	13,526	1,299
Kalispell	....	6,388	584
Nebraska:			
Omaha	242	43,478	8
New Hampshire:			
Claremont	....	852	....
Keene	81	4,458	....
Lebanon	....	2,200	....
New Jersey:			
Belleville	....	8,834	....
Bound Brook	....	3,736	....
Nutley	....	500	....
Plainfield	....	96,000	....
Ridgewood	....	40,983	....
West Orange	....	25,860	....
New York:			
Elmira	....	24,684	....
Herkimer	....	9,790	....
Mt. Vernon	....	25,459	....
Ossining	....	16,002	....
Salamanca	....	5,000	....
North Carolina:			
High Point	10,027	13,444	5,933
Rocky Mount	....	7,800	....
Ohio:			
Bucyrus	....	1,700	....
Cincinnati	1,366	139,523	15,048
Conneaut	....	5,846	....
Warren	....	31,270	....
Oklahoma:			
Bartlesville	....	12,000	....
Oregon:			
Eugene	10,151	1,926	6,670
Pennsylvania:			
Clearfield	3,269	2,635	....
Freeland	....	1,200	....
Huntingdon	2,600	480	....
Mt. Union	250	7,000	....
Rhode Island:			
Westerly	....	5,573	....
South Carolina:			
Batesburg	....	12,000	....
Charleston	1,305	2,244	....
South Dakota:			
Sioux Falls	....	10,021	....
Tennessee:			
Union City	....	1,200	600
Texas:			
El Paso	10,470	26,620	....
Galveston	....	155,961	....
Laredo	....	16,000	....
Paris	200	50	....
San Antonio	....	96,789(b)	....
Wichita Falls	5,500	5,300	....
Vermont:			
Montpelier	264	300	....
Morrisville	....	600	....
Newport	....	1,500	....
Virginia:			
Richmond	28,897	....	....
Washington:			
Olympia	....	1,200	....
Spokane	....	67,558	....
Wenatchee	....	1,900	....
Yakima	4	6,545	....
Wisconsin:			
Antigo	....	3,037	....
Janesville	....	9,600	5,100
Kaukauna	....	4,681	....
Kenosha	96	31,119	692
Manitowoc	....	17,074	303
Menasha	....	2,184	....
Milwaukee	....	249,286	34,308
Neenah	....	6,400	....
So. Milwaukee	....	4,000	....
Superior	330	4,698	....
Watertown	....	4,989	....
Wausau	3,597	11,066	1,177
Whitewater	800	....	....
Wyoming:			
Buffalo	....	2,000	400

Notes: (a) Includes Saco and Old Orchard; (b) All sizes.

Water Treatment

State and City	Are Sedimentation Basins Used?	Kind of Filters	Do You Chlorinate?	Do You Soften?	Millions of Gallons Treated
Alabama:					
Bessemer	No	....	Yes	No	All
Decatur	Yes	....	Yes	No	480
Arizona:					
Tucson	No	....	Yes	No	1,626
Arkansas:					
Fort Smith	Yes	Rapid	Yes	No	....
California:					
Brawley	....	None	Yes	No	600
El Centro	Yes	Rapid	Yes	No	670
Red Bluff	No	....	Yes	....	....
San Jose	No	....	Yes	....	1,000
Santa Barbara	No	....	Yes	No	1,673
Vallejo	No	....	Yes	No	650
Colorado:					
Greely	Yes	Slow	No	No	....
Connecticut:					
Putnam	Yes	Rapid	Yes	Some	558
Southington	No	....	Yes	....	....
Wallingford	Yes	Rapid	Yes	No	1,000
Willimantic	No	....	Yes	No	....
Delaware:					
Wilmington	Yes	Slow & Rapid	Yes	No	5,317
Florida:					
Live Oak	No	....	Yes	No	82
Orlando	Yes	Rapid	Yes	No	913
Tampa	Yes	Rapid	Yes	Yes	3,650
Georgia:					
Albany	No	....	Yes	No	342
Thomasville	No	....	Yes	No	....
Illinois:					
Danville	Yes	Rapid	Yes	No	2,000
Highland Park	No	....	Yes	No	730
Hillsboro	Yes	....	Yes	No	100
Lincoln	No	....	Yes	No	390
Litchfield	Yes	Rapid	Yes	No	240
Mattoon	Yes	....	Yes	No	....
Oak Park	No	....	Yes	No	....
Paris	Yes	Rapid	Yes	....	440
Quincy	Yes	Rapid	Yes	No	1,000
Sterling	No	....	Yes	No	....
Indiana:					
Brazil	....	....	Yes	No	160
Elkhart	....	....	Yes	....	1,300
Logansport	Yes	Slow	Yes	No	2,000
Muncie	Yes	Rapid	Yes	No	1,375
New Albany	Yes	Rapid	Yes	....	720
Peru	No	....	Yes	No	1,100
Princeton	Yes	Rapid	Yes	Yes	360
Richmond	No	....	Yes	No	1,400
Whiting	Yes	Rapid	Yes	No	985
Iowa:					
Ames	Yes	Rapid	Yes	No	290
Burlington	Yes	Rapid	Yes	No	993
Oskaloosa	Yes	Rapid	Yes	No	269
Sioux City	No	....	Yes	No	....
Kansas:					
Lawrence	Yes	Gravity	Yes	Yes	480
Ottawa	Yes	Yes	Yes	Some	350
Kentucky:					
Hazard	Yes	Rapid	Yes	No	127
Louisiana:					
Baton Rouge	No	....	Yes	No	825
Maine:					
Biddeford	Yes	Rapid	Yes	No	764
Houlton	No	....	Yes	No	400
Portland	No	....	Yes	....	4,449
Maryland:					
Hagerstown	Yes	Rapid	Yes	No	1,647
Salisbury	Yes	....	....	....	200
Massachusetts:					
Athol	....	Rapid & Slow	No	No	....
Cambridge	Yes	Rapid	Yes	....	4,493
Framingham	No	....	Yes	No	539
Middleborough	No	Coke & Slow Sand	No	No	96
So. Hadley Falls	No	....	Yes	No	....
Springfield	Yes	Slow	Some	No	5,570
Woburn	No	....	Yes	No	693
Michigan:					
Boyne	Yes	....	No	No	....
Escanaba	Yes	....	Yes	No	463
Marquette	No	....	Yes	No	....
Mt. Clemens	Yes	Rapid	Yes	No	....
Traverse City	No	....	Yes	No	554
Minnesota:					
Cloquet	....	....	Yes	....	....
International Falls	....	....	Yes	....	....
Minneapolis	Yes	Rapid	Yes	No	17,361
Northfield	Yes	Brass Screen	No	No	....
Rochester	No	....	Part	No	....
Mississippi:					
Jackson	Yes	Rapid	Yes	No	1,800
Natchez	No	....	Yes	No	230
Missouri:					
Jefferson City	Yes	Rapid	Yes	Yes	150
Moberly	Yes	Rapid	Yes	No	150
Montana:					
Billings	Yes	Rapid	Yes	No	846
Great Falls	Yes	Rapid	Yes	No	1,601
Missoula	No	....	Yes	No	....
Nebraska:					
Omaha	Yes	Rapid	Yes	No	9,918
New Hampshire:					
Claremont	No	....	Yes	No	171
Keene	No	Slow	No	No	550
Lebanon	No	Rapid	Yes	No	....
Somersworth	No	Slow	Yes	No	170
New Jersey:					
Belleville	Yes	Pressure	Yes	No	....
Ridgewood	....	....	Yes	....	....
New York:					
Elmira	No	Rapid	Yes	No	2,200
Herkimer	No	....	Yes	No	292
Little Falls	No	Slow	Yes	No	....
Norwich	No	Pressure	Yes	No	471
Ossining	No	....	Yes	No	300
Salamanca	No	....	Yes	No	380
North Carolina:					
High Point	Yes	Rapid	Yes	No	840
Rocky Mount	Yes	Rapid	Yes	No	396
Ohio:					
Bucyrus	Yes	Rapid	Yes	No	386
Cincinnati	Yes	Rapid	Yes	No	19,909
Conneaut	Yes	Rapid	Yes	No	664
Greenville	Yes	Sand	Yes	Yes	200
Sandusky	Yes	Rapid	Yes	No	1,500
Warren	Yes	Rapid	Yes	No	1,070
Oklahoma:					
Bartlesville	Yes	Rapid	Yes	No	350
Vinita	Yes	Slow	Yes	No	143
Oregon:					
Corvallis	No	....	Yes	No	All
Eugene	Yes	Rapid	Yes	No	933
Pennsylvania:					
Ford City	Yes	Rapid	Yes	Yes	163
Freeland	No	....	Yes	No	98
Huntingdon	Yes	Rapid	Yes	No	430
Mt. Union	No	....	Yes	....	150
Phillipsburg	No	....	Yes	....	223
Steelton	Yes	Coal & Slow	Yes	Yes	540

South Carolina:							
Batesburg	....	....	....	1,892	....	....	....
Charleston	Yes	Yes	Rapid	2,000	729	Yes	....
Columbia	Yes	Yes	Rapid	....	1,916	Yes	....
South Dakota:							
Madison	....	Yes	....	109	....	....	....
Sioux Falls	Yes	Yes	Sand	1,208	....	....	....
Tennessee:							
Clarksville	Yes	Yes	Rapid	300	524	Yes	....
Texas:							
Childress	Yes	Yes	....	160	....	....	....
Galveston	No	Yes	....	1,642	1,121	Some	....
Laredo	Yes	Yes	Rapid	1,006	152	Yes	....
Paris	Yes	Yes	Rapid	350	538	No	....
Weatherford	No	Yes	....	....	....	....	....
Wichita Falls	Yes	Yes	Rapid	....	....	....	....
Vermont:							
Montpelier	No	Yes	....	182	....	....	....
Virginia:							
Lexington	No	Yes	....	900	....	....	....
Washington:							
Olympia	No	Yes	....	....	....	....	....
Walla Walla	No	Yes	....	....	....	....	....
Wenatchee	Yes	Yes	Rapid	991	....	....	....
Yakima	No	Yes	....	....	....	....	....
Wisconsin:							
Appleton	Yes	Yes	Rapid	729	....	....	....
Kenosha	Yes	Yes	Rapid	1,916	....	....	....
Menasha	Yes	Yes	Rapid	524	....	....	....
Milwaukee	No	Yes	....	....	....	....	....
So. Milwaukee	Yes	Yes	Rapid	....	....	....	....
Superior	No	Yes	Slow	....	....	....	....
Two Rivers	No	Yes	....	....	....	....	....
Wausau	Yes	No	Rapid	538	....	....	....
Wyoming:							
Buffalo	Yes	Soon will	Pressure	....	....	....	....

STEEL PIPE LAID IN 1928

City and State	Under 12-inch	12-inch and over
Hayward, Calif.	2,448	.....
San Jose, Calif.	16,180	6,900
Muncie, Ind.	12,700	.....
International Falls, Minn.	19,610	.....
Minneapolis, Minn.	.....	18,740
Missoula, Mont.	1,000 all sizes	.....
Rocky Mount, N. C.	4,000	.....
Corvallis, Ore.	7,000	18,000
Eugene, Ore.	231	.....
Laredo, Tex.	20,000	.....
Richmond, Va.	4,551	3,604
Walla Walla, Wash.	704	490
Buffalo, Wyo.	10 miles	3.5 miles

Notes on Water Pipes

Long Beach, Calif., has in use 19,953 feet of 16-inch to 30-inch concrete pipe.

Burley, Idaho, has in use 59,800 feet of 3-inch to 12-inch wood pipe, made of fir. Athol, Mass., has 4,000 feet of 16-inch wood pipe.

Cambridge, Mass., laid 1,405 feet of 6-inch cement-lined pipe. Springfield, Mass., has 29,365 feet of 24-inch cement-lined pipe in use.

Middleboro, Mass., laid 752 feet of 1-inch cast-iron pipe, and has more than 76,000 feet of such pipe in use.

Wenatchee, Wash., laid 600 feet of wood pipe, all under 12-inch. Yakima, Wash., laid 207 feet of machine-banded wood pipe.

Cleveland, O., laid 1,000 feet of 8 to 12-inch wrought iron pipe and now has 10,000 feet of such pipe in use.

Raleigh, N. C., has 144,672 feet of 1 and 2-inch wrought iron pipe in use, which is about 25 per cent of the total length of pipe in the system.

Paving By Flint's Municipal Force

Organization of force and equipment used in laying twenty-one miles of pavement. Semi-permanent gravel road

In Flint, Michigan, a large part of the paving is done by the city forces under the city engineer, contracts being let only for such work as the city does not feel justified in performing, either because it would require a large temporary increase in the force or the purchase or rental of additional equipment for this particular job.

During the fiscal year ending February 28, 1929, 21 miles of streets were paved by the city forces, of which 10½ miles were for a "modern housing corporation" and the rest distributed over the rest of the city. In addition to this, 5.62 miles of brick and concrete pavements were built by contract on fifteen streets, and pavements were widened and resurfaced on five streets. Among the contract work performed was something over 50,000 square yards of asphalt-filled brick surface on a 9-inch concrete base and about 56,000 square yards of concrete slab pavement on thirteen streets.

The city forces, using two pavers on foundation work, poured 311,000 square yards of foundation in 372 possible working days with two crews. Delays on account of bad weather conditions, moving, repairs, delivery of materials and miscellaneous delays accounted for a total of 171 days of accumulated delays for the two pavers.

Seventeen crews were employed on various items of construction during the greater part of the season and the payroll on pavement work ran as high as 300 employees at one time. Of these crews, five have taken care of excavation, two of fine grading, four of curb and gutter construction and sidewalk adjustment, three of foundation work, one of drainage and brick surface, and two of clean-up.

Five steamshovels, three belonging to the department and two being rented, were used for excavating about 184,000 cubic yards. Three of these steam shovels were equipped with Caterpillar tread and these showed a marked superiority as regards speed over the old type, this equipment moving approximately one-third more material than the shovels operating on mats.

The curb trenching gang, whose duties were formerly included in the work of fine grading, was introduced in 1928 and gave excellent results. A single gang kept ahead of all four curb construction crews and it was very rarely necessary for the latter to do their own curb trenching. The two experienced curb construction crews built rapidly and well and two newly organized crews were broken in late in the season and aided very materially in the completion of approximately 37 miles of curb and gutter. In fine grading operations, a single crew was for a long time able to keep the grade prepared well ahead of two pavers. Innovations in the method of fine grading were introduced, a templet being used in place of the ordinary grade lines wherever possible. As the season advanced it became necessary to organize a second fine-grade crew, which worked entirely by lines be-

cause of the lack of better equipment. Approximately 350,000 square yards of fine grading was completed.

Several small crews under a single foreman were employed in building and rebuilding catchbasins, manholes and leads, in laying 8,243 square yards of brick surfacing and in repairing sewers broken or damaged by the construction crews.

Three paving mixers were used on foundation work, two of them 27-E Rex machines, and the third a rented 21-E Ransome mixer. On several occasions the 27-E's obtained a maximum output of more than 2,000 yards each, when the grades were unusually good and material deliveries particularly satisfactory. Later in the season, when rains softened the subgrade and when materials were less certain in delivery, their output fell off somewhat. Approximately 290,000 square yards of foundation were poured by the two city pavers.

Two regularly organized clean-up crews handled very extensive yardage quite satisfactorily and the streets never looked really presentable and finished until they had been gone over by this polishing up crew. The curb crews, as they finished with their regular work, were put on sidewalk adjustment. The other crews from shovels, mixers and fine grading were put on the clean-up crew as they were relieved from their regular duties.

The year 1928 was the first during which the city of Flint constructed gravel streets designed for a more or less permanent improvement. After a thorough consideration of the much needed street improvements in the outlying districts where storm sewer drainage was not available, the city council adopted the recommendation of the superintendent of streets providing for an increased thickness of gravel roads from 6 inches to an average of 9 inches; and after noting the result of a year's work, the department is firmly convinced that no mistake was made. Although the cost has been greater than for gravel roads constructed in past years, the additional expense is believed to be fully justified.

During the season a total length of 97,337 lineal feet of gravel roads were completed, except for the chloride or top course of gravel still to be applied on 12 streets out of the 72. These figures do not include approximately two miles of 26-foot gravel roads constructed for the board of water commissioners on new streets in the vicinity of Kearsley creek dam, in which a total of 43,367 cubic yards of gravel was used.

Special attention was called to a job on Woodcroft avenue, where concrete curb with underdrainage was placed before gravel surfacing was done. This gave an exceptional semi-permanent improvement which is recommended for all streets where it is possible to obtain drainage to existing storm sewers and where the expense of asphalt pavements would not be justified at the time.

Details of the work done last year show a total of 55,637 square yards of 8-inch foundation, 247,382 square yards of 7-inch foundation, and 3,096 square yards of concrete. On these foundations was placed 294,771 square yards of 3-inch asphalt surface and 8,248 square yards of brick surface. The unit costs of the work were as follows; Excavation, 53.3c per cubic yard; curb and gutter, 65.5c per lineal foot; fine grading, 10c per square yard; foundation, $1.205 per square yard; brick surface, $2.17 per square yard; asphalt surface, 98c per square yard; concrete pavements, $2.50 per square yard; clean-up, 8.4c per square yard; engineering, 7.7c per square yard. Adding walk adjustment, garage and other miscellaneous items, gives total costs per square yard of asphalt pavement $3.34, brick pavement $5.50, concrete pavement $4.215.

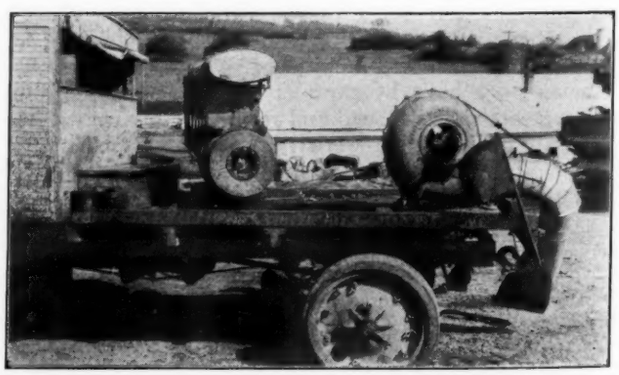
Ten Million Dollar Road Contract in England

The Lancashire County Council, England, has received a bid of something over two million pounds for building, between Liverpool and Manchester, a road twenty-five miles long with a pavement forty feet wide, of concrete with asphalt top. The right of way is 120 feet wide, and later a 20-foot roadway and 10-foot sidewalk with sodded strip between will be built on each side. Thirty-two bridges and the demolishing of 130 houses are included in this project —one of the most important in England from a commercial standpoint. The national government will contribute 75 per cent of the cost, the county about 15 per cent, and the remainder will be paid by a number of municipalities.

Blower for Virginia Roads

The Department of Highways of Virginia is using a blower attachment to a Fordson tractor which was prepared in the department's equipment depot for use in cleaning dust from the highways preparatory to surface treatment. The accompanying photograph of the blower, together with this information, were kindly furnished us by C. S. Mullen, chief engineer, and J. J. Forrer, assistant engineer of maintenance. This photograph shows a blower installed on a truck driven by a Fordson power unit. This was the first development of the device. Later it was found that the blower could be attached to a Fordson tractor.

The blower used is a No. 6 Champion, manufactured by the Champion Blower & Forge Co. of Lancaster, Pa. It has an 11-inch opening and requires about 11¾-inch pipe, which extends to within about 6 inches of the ground, where it is flared into a nozzle with an opening of 1½ inches by about 20¼ inches. This blower is attached to the rear end of the Fordson by means of a power take-off known as "Tacoff" manufactured by the Tractor Appliance Company of New Holstein, Wis. The equipment depot states that the total cost of the blower attachment ready to operate is about $161.39 apiece, as eighteen of them were made at one time at a total cost $2,915.08.



DUST BLOWER MOUNTED ON TRUCK AND DRIVEN BY FORDSON MOTOR.

Recent Legal Decisions

APPLICATION OF SURPLUS FROM OPERATION OF MUNICIPAL WATER PLANT

The Circuit Court of Appeals, Fifth Circuit, in St. Louis-San Francisco Ry. Co. v. Moore, 25 Fed. (2) 964, holds that under section 27 of article 10 of the Oklahoma Constitution a town of less than 2,000 population, operating waterworks for which it has issued bonds, is not required to comply with the provision of Okla. Comp. St. 1921, §4507, which would require it to apply the surplus over the operating expenses of the waterworks plant to the interest and sinking fund of the construction bonds, the Supreme Court of Oklahoma having decided, in Kansas City Southern Ry. Co. v. Wood, 126 Okla. 275, that section 4507 has no application to cities and towns of less than 2,000 population.

CALIFORNIA WATER DISTRICT ACT HELD CONSTITUTIONAL AND VALID

The Supreme Court of California holds, City of Pasadena v. Chamberlain, 269 Pac. 630, that the Metropolitan Water District Act (Cal. St. 1927, p. 694) is a general law although its operation is confined to the corporate limits of municipalities and it confers benefits on the residents thereof in the matter of distribution of water for domestic purposes not available to residents or owners of property within unincorporated areas within the general territory affected by the water district. The matter of the distribution of water for domestic uses in cities having compacted populations within limited areas is very different in the detail of its operation and service from that possible or practical in unincorporated areas occupied by a scattered population. The act is held not unconstitutional as giving persons affected no voice in the formation of a district although it provides that a single municipality may set in motion the proceedings for the formation of a water district, since it provides that it shall not be operative as to each municipality until the initial proceedings are approved by a majority of the electors thereof at a special election.

It was also held that the Legislature, in investing metropolitan water districts to be formed under the provisions of the act in question, with power, through their properly appointed officials, to collect general taxes within the municipalities uniting in the formation of such districts for the common purpose of supplying each with water for domestic purposes has not acted in violation of the due process clause of the state Constitution.

NUISANCE CAUSED BY SEWER SYSTEM—NECESSARY PROOF THAT NUISANCE CAUSED ILLNESS FOR WHICH DAMAGES SOUGHT

In an action against a municipal corporation for the negligent maintenance of a sewer system, causing a nuisance in the near vicinity of the plaintiff's home, discomfort, annoyance, and personal inconvenience caused by the offensive odors, and sickness caused by disease germs from such nuisance were held proper items of damages, City of Sayre v. Rice, Oklahoma Supreme Court, 269 Pac. 361. But where, in such action, one of the items of damages was sickness suffered by plaintiff and her family during two or three successive summers while the nuisance existed, a mere showing that the defendant caused its sewage to be discharged upon the ground between 200 and 300 yards from plaintiff's home, and that the plaintiff and her family suffered from fevers during two or three consecutive summers, was held not a sufficient showing that the illness was the proximate result of the nuisance, and, in the absence of some connecting evidence, it was error to submit the question of illness to the jury as an item of damage.

HYDRAULIC AND WATER SUPPLY ENGINEERS NOT EXPERTS AS TO VALUE OF LAND

The New Jersey Court of Errors and appeals holds, Ringwood Co. v. North Jersey District Water Supply Commission, 143 Atl. 369, following Ross v. Commrs. of the Palisades Interstate Park, 90 N. J. Law 461, that hydraulic and water supply engineers, as such, are not qualified to testify to the market value of land under condemnation, under the cases in New Jersey. They may, however, testify to the natural advantages of the land, its freedom from population, its availability for water supply development, the character of the supply there capable of being developed, and kindred matters. What are the requisite qualifications for a witness to testify, as an expert, on the value of land must be left very much to the discretion of the trial judge; his decision is conclusive, unless clearly shown to be erroneous in matter of law.

NEGLIGENCE IN MAINTAINING INSECURE WATER METER BOX COVER ON PATHWAY

The Georgia Court of Appeals holds, Davis v. City of Rome, 142 S. E. 171, that a strip of land in a city street, separated from that part of the street used for vehicular traffic by a small ditch, and lying between the ditch and a private abutting lot, and used, with knowledge of the city, by pedestrians as a pathway, being part of the public street, is necessarily dedicated to public use as a pathway for pedestrians; and, irrespective of whether it can be called a "sidewalk" which the city is under a duty to keep in repair and render safe for travel, the city is nevertheless under a duty, when creating and maintaining any condition in the pathway, to exercise due care for the safety of pedestrians using the pathway. The maintenance of a water meter box on the pathway in such a condition that the top of the box was continually knocked off by passing pedestrians leaving an unprotected opening in the pathway, the condition lasting several years, was held to authorize the inference that, as against a pedestrian, the city knew of and was negligent in maintaining such condition, and a pedestrian stepping into the opening could recover for his resulting injuries.

MUNICIPAL TAXATION AUTHORIZED FOR AVIATION FIELD

The Nebraska Supreme Court, State ex rel. City of Lincoln v. Johnson, 220 N. W. 273, holds that an equipped aviation field in or near a city, being a means of making aerial service available to passengers and the service including the transportation

of mail and freight, is furnished for a public purpose for which taxes may be imposed in the exercise of governmental power. An equipped municipal aviation field is both a "public service property" and a "public utility" within the meaning of the Lincoln Home Rule Charter, which authorizes municipal bonds upon a majority vote.

ATTRACTIVE NUISANCE DOCTRINE NOT APPLICABLE TO CHOKE COIL TWENTY FEET ABOVE GROUND ON ELECTRIC LIGHT POLE

The South Dakota Supreme Court holds, Reddy v. City of Watertown, 220 N. W. 851, that a city operating a municipal electric light plant and maintaining a pole in an alley on which was a transformer on a platform 14-feet above the ground and a high-voltage choke coil 6-feet above the transformer, was not negligent as to a boy who was killed when he climbed the pole and grasped the choke coil.

LIABILITY FOR POLLUTION OF STREAM BY SEWAGE—CONTRIBUTORY NEGLIGENCE AS A DEFENSE

The Oklahoma Supreme Court holds, City of Enid v. Brooks, 269 Pac. 241, that the pollution of a stream by the discharge of sewage into it caused by the negligent operation and maintenance of a municipal sewer system by the officers and agents of the municipality gives a riparian proprietor injured thereby a right of action against the municipality. The fact that the stream may have been polluted from other sources would, it is held, be no defense or excuse for the municipality to add thereto, and would be no defense to a recovery for any damages caused by its act. Although it is a general rule that if the negligence of the injured party, as by causing sewage from his home to be emptied into the stream, contributed in any degree to the injury complained of no recovery could be had, contributory negligence is an affirmative defense, and must be pleaded. It cannot be raised by a general denial; and it cannot be raised in the Supreme Court for the first time.

OIL AND GASOLINE FURNISHED SEWER CONTRACTOR HELD LIENABLE MATERIALS UNDER KENTUCKY STATUTE

The Kentucky Court of Appeals, Mid-Continent Petroleum Corporation vs. Southern Surety Co., 9 S. W. (2d) 229, says that there is a diversity of opinion among the courts as to whether coal and gasoline, used to generate power, and oil, used to lubricate machinery, employed by the contractor in construction work, are or are not liable articles. The cases holding that they are not are from states where the lien statute is strictly construed. The Kentucky court is of opinion that the lien statute should be liberally construed, and accordingly holds that gasoline and oil furnished a contractor constructing a sewer, for use in an engine used in such construction, are lienable materials. The Kentucky court holds that: "While county or municipal property devoted to public use will not be sold to satisfy a materialman's lien, one furnishing materials to the contractor may file his lien and have subjected to the payment of his debt money due to the contractor by the municipality. Allen County vs. U. S. Fidelity and Guaranty Co., 122 Ky. 825. In some states where the lien statute is not so construed, statutes have been passed making it the duty of public officials in making contracts for public work of any kind to be performed for the state or any subdivision thereof, to require every contractor to execute bond conditioned for the payment of material used and all labor performed in such work."

MUNICIPALITY HELD NOT LIABLE FOR OVERFLOW FROM DRAIN

The Indiana Appellate Court, City of Logansport v. Cottner, 163 N. E. 277, holds that a city, in constructing a local tile drain exclusively for surface waters, which benefited only private persons, who were assessed for the total cost, was exercising a governmental function. It was under no duty to maintain or repair the drain, or to supervise or control it, and was not liable in damages for permitting it to become so obstructed as to overflow into the cellars of an adjacent owner, especially in view of Burns' Ann. St. 1926 §6218, charging the township trustee with the duty of superintending and maintaing drains.

LIMITATION OF HEIGHT OF BUILDINGS TO SUIT SEWER FACILITIES

The New Jersey Court of Errors and Appeals holds, Van Duyne v. Senior, 143 Atl. 437, that the limitation, in the building code of a town, of the height of appartment houses for more than six families to three stories, was reasonable and valid, in view of the sewer situation in the town, under which the erection of higher buildings would render the sewage facilities of the municipality highly inadequate and a menace to the health and safety of the inhabitants, and which condition would require two or three years to remedy.

ZONING ORDINANCE AND BUILDING INSPECTOR'S DECISION PRESUMED REASONABLE

The New Jersey Supreme Court holds, Sharff v. Board of Adjustment of City of East Orange, 143 Atl. 77, that, to overturn, on appeal to the board of adjustment, an adverse decision of the building inspector who has refused a permit, some evidence should be proffered to show that he was wrong, and to overcome the presumption that the zoning ordinance was reasonable in its application.

PUBLIC WORK MAY BE ACCEPTED WITHOUT ARCHITECT'S FINAL CERTIFICATE PROVIDED FOR BY CONTRACT

Under a contract between a school board and a contractor providing that the architect had full power to reject the whole or any part of the material or work which might not in his opinion be in strict accordance with the letter and spirit of the contract, his decision on all matters to be binding and conclusive on both parties, the Washington Supreme Court holds, Union High School Dist. v. Pac. Northwest Const. Co., 269 Pac. 809, that the architect's recommendation of a conditional acceptance of the work would not prevent the board making an absolute acceptance if it desired to do so. The board can waive any provision in the contract placed there for its benefit. Where the board voluntarily accepted a school building prior to the issuance of the architect's final certificate, the period for filing claims under Washington Kem. Comp. Stat. §1161 was held to expire 30 days after the acceptance, and a later resolution of acceptance by a new board of directors did not invalidate the first acceptance, nor extend the time for filing claims against the contractor's bond.

Engineering Societies

June 18-20—NEW YORK STATE CONFERENCE OF MAYORS AND OTHER CITY OFFICIALS. Annual Meeting at Binghamton, N. Y. Secretary, William P. Capes, City Hall, Albany, N. Y.

June 24-28—AMERICAN WATER WORKS ASS'N. Annual Convention at Toronto, Ont., Beekman C. Little, Secretary, 29 W. 39th St., N. Y.

July 10-12—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual Meeting at Milwaukee, Wisc. George T. Seabury, Secretary, 33 W. 39th St., New York.

Aug. 25-27—AMERICAN ASSOCIATION OF ENGINEERS. Annual Convention at Mexico City. M. E. McIver, Secretary, Chicago, Ill.

Sept. 17-20—NEW ENGLAND WATER WORKS ASSOCIATION. Annual Convention at Portland, Me. F. J. Gifford, Secretary, 715 Tremont Temple, Boston, Mass.

Sept. 30-Oct. 4.—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual Convention at Minneapolis, Minn. Homer M. Calver, Secretary, 370 Seventh Ave, N. Y.

Oct. 14-16—SOUTHWEST WATER WORKS ASSOCIATION. Annual Convention at Tulsa, Okla. L. A. Quigley, Secretary, Fort Worth, Tex.

Oct. 14-16—INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Annual Convention at Jacksonville, Fla. A. M. Anderson, Secretary, 100 North LaSalle St., Chicago, Ill.

Oct. 14-18—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual Convention at Philadelphia, Pa. C. V. S. Sammelman, Secretary, St. Louis, Mo.

Nov. 12-14—NATIONAL MUNICIPAL LEAGUE. Annual Convention at Chicago, Ill. Secretary, Russell Forbes, 261 Broadway, N. Y.

Nov. 20-23—INTERNATIONAL CITY MANAGERS' ASSOCIATION. Annual Convention at Fort Worth, Tex. Executive Secretary, John G. Stutz, Lawrence, Kans.

American Water Works Association

The preliminary program for the meeting to be held at Toronto, Ont., June 24 to 28, is as follows, all hours being daylight saving time:

Monday—8:00: Registration; 9:00: Committee on Water Works Practice, Malcolm Pirnie, Chairman. Hazen, Everett & Pirnie, Consulting Engineers, New York, N. Y.; 11:00: Executive Committee.

2:00: Plant Management and Operation Division and Superintendent's Round Table Discussion. H. F. Huy, Chairman, General Manager, Western New York Water Company, Buffalo, N. Y. The following members will lead the discussions: J. W. Ackerman, Watertown, N. Y.; W. W. Brush, New York, N. Y.; C. K. Calvert, Indianapolis, Ind.; W. S. Cramer, Lexington, Ky.; F. C. Dugan, Louisville, Ky.; J. E. Gibson, Charleston, S. C.; D. E. Kepner, Denver, Colo.; M'Kean Maffit, Wilmington, N. C.; W. S. Patton, Ashland, Ky.; A. U. Sanderson, Toronto, Ont., Canada; J. F. Skinner, Rochester, N. Y.; L. A. Smith, Madison, Wis.

2:00: Committee No. 1—Standard Methods of Water Analysis. J. J. Hinman, Jr., Chairman, Associate Professor of Sanitation, University of Iowa, Iowa City, Iowa. Everybody welcome.

9:00: Informal reception and dance; Address of welcome by the Mayor of Toronto.

Tuesday—9:00: General Session. Opening of Convention. Announcement of Officers and Trustees elected for year 1929-30. New Business, etc. 9:00: Recent Developments in Boiler Operation and Their Influence on Feedwater Treatment, Sheppard T. Powell, Chemical Engineer, Baltimore, Md.; Deaeration of Boiler Feedwater, J. R. McDermet, Research Engineer, Elliott Company, Jeannette, Pa.; The Dissociation of Water in Steel Tubes at High Temperatures and Pressures, illustrated by lantern slides, C. H. Fellows, Detroit Edison Company, Detroit, Mich.; Calculation of Chemicals for Water Softening, A. M. Buswell, Chief, State Water Survey, Urbana, Ill.

2:00: General Session. Symposium on Pumping Station Practice: Selection of Pumping Station Equipment, illustrated by lantern slides, A. P. Pigman, American Water Works & Electric Company, New York, N. Y.; Equipment for Electrically Driven Pumping Stations, R. L. Baldwin, Burns & McDonnell, Consulting Engineers, Kansas City, Mo.; Pump Discharge Headers and Pump Piping for Waterworks Stations, illustrated by lantern slides, F. G. Cunningham, Fuller & McClintock, Consulting Engineers, New York, N. Y.; Selection of Equipment for Clove Pumping Station of Staten Island System, William Flannery, Mechanical Engineer, Department of Water Supply, Gas & Electricity, New York, N. Y.; Comparative Data on Steam and Electrical Pumping Stations, illustrated by lantern slides, John F. Laboon, J. N. Chester Engineers, Pittsburgh, Pa. 2:00: The Prevention of Pitting in Locomotive Boilers by Exclusion of Dissolved Oxygen from the Feedwater, C. H. Koyl, Engineer of Water Service, Chicago, Milwaukee, St. Paul & Pacific Railroad Company, Chicago, Ill.; Railway Water Treatment Progress and Research Requirements, R. C. Bardwell, Superintendent Water Supply, Chesapeake & Ohio Railway Company, Richmond, Va.; Hydrogen Ion and Conductivity Measurement, illustrated by lantern slides, C. Z. Rosecrans, Chief of Chemical Division, Leeds & Northrup Company, Philadelphia, Pa.

6:45: Dinner, Water Purification Division; 8:00. Ladies' Card Party.

Wednesday—9:00: Business Meeting Canadian Section.

10:00: General Session—(This session will open one hour later than ordinarily to provide for the business meeting of the Canadian Section and obviate decreased attendance which would otherwise occur if the two meetings were held concurrently.); Ethics for Engineering Services, Nicholas S. Hill, Jr., Consulting Engineer, New York, N. Y.; Durability of Distribution Systems, illustrated by lantern slides, H. Y. Carson, National Cast Iron Pipe Company, Birmingham, Ala.; Operating Experiences with Large Capacity Filter Plants, J. Clark Keith, Chief Engineer, Essex Border Utilities Commission, Windsor, Ont., Canada.

9:00: Water Purification Division.

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Values in Natural and Artifical Purification with Reference to the Sangamon River at Springfield, Ill., illustrated by lantern slides, Charles H. Spaulding, Chemist and Superintendent of Purification, Springfield, Ill.; The Deposition of Manganese Dioxide in the Aqueduct of the Catskill Water Supply, Frank E. Hale, Director of Laboratories, Department of Water Supply, Gas and Electricity, New York, N. Y.; Micro-organisms in the Lake Michigan Water and Their Effect on Filtration, illustrated by lantern slides, John R. Baylis and H. H. Gerstein, Bureau of Engineering, Chicago, Ill.; Innovations in the Treatment of Water in the Province of Ontario, A. V. DeLaporte, Chemist, Department of Health of Ontario, Toronto, Ont., Canada; Some Unusual Features in Design of the New Water Purification Plant at Niagara Falls, F. A. Dallyn, Civil Engineer, Toronto, Ont., Canada.

2:00: General Session. Field Practice in Chlorination of New and Old Water Mains, Joseph S. Strohmeyer, Asst. Civil Eng., Water Department, Baltimore, Md.; The Chlorine Institute Standard Valve for Chlorine Containers, illustrated by lantern slides, R. T. Baldwin, Secretary, The Chlorine Institute, New York, N. Y.; Cobble Mountain Dam of the Springfield, Mass., Water Works, illustrated by lantern slides, Allen Hazen, Hazen, Everett & Pirnie, Consulting Engineers, New York, N. Y.; Water-Borne Epidemics on Ships with Reference to the Outbreak on the Lake Gaither, I. W. Mendelsohn, U. S. Public Health Service, New York, N. Y.

8:00: General Session—Preceding Smoker. The Toronto Water Works System, R. C. Harris, Commissioner of Works, Toronto, Ont., Canada; The New Filtration Plant and Other Extensions of the Toronto Water Works, illustrated by lantern slides, William Gore, Consulting Engineer, Toronto, Ont., Canada. 8:00: Ladies' Theatre Party; 9:30: Smoker.

Thursday—Plant Management and Operation Division, H. F. Huy, Chairman, General Manager, Western New York Water Company, Buffalo, N. Y. 9:00: Business Meeting of Division. Pure Stream Movement will Accomplish Its Purpose, Scotland G. Highland, General Manager, Clarksburg Water Board, Clarksburg, W. Va.; Cement for Cast Iron Pipe Joints, O. G. Goldman, Assistant Superintendent of City Distributing System, Spring Valley Water Company, San Francisco, Calif.; Management and Operation of a Canadian Water Works System, W. E. MacDonald, City Water Works Engineer, Ottawa, Ont., Canada. Discussion—J. Walter Ackerman, City Manager, Watertown, N. Y.; R. L. Dobbin, Superintendent Water Works, Peterborough, Ont., Canada; G. G. Routledge, Superintendent Water Distribution, Toronto, Ont., Canada; The Two-Main System of Water Distribution, illustrated by lantern slides, J. B. Eddy, Engineer, Water Pipe Extensions, 404 City Hall, Chicago, Ill.

Water Purification Division—9:00: The Relation of Direct B. Coli and B. Aerogenes Counts, Obtained on Cyanide-Citrate Agar, to Sources of Pollution, illustrated by lantern slides, Fred O. Tonney and R. E. Noble, Bureau of Laboratories and Research, Department of Health, Chicago, Ill.; Lactose Fermenting Bacilli Growing on Leather Washers, Frank E. Greer and Laura C. Kells, Bureau of Laboratories and Research, Department of Health, Chicago, Ill.; Ultra-Microscopic Studies of Colloids in Water, C. H. Christman, National Aluminate Corporation, Chicago, Ill.; The Use of Activated Carbon in Removing Taste Producing Substances from Water, illustrated by lantern slides, John R. Baylis, Physical Chemist, Bureau of Engineering, Chicago, Ill.

2:00: General Session, G. G. Dixon, Chairman, Deputy Chief Engineer, Mahoning Valley Sanitary District, Youngstown, Ohio; Symposium on Large Size Pipe Lines: Welded Steel Pipe at Springfield, Mass., illustrated by lantern slides, Allen Hazen, Hazen, Everett & Pirnie, Consulting Engineers, New York, N. Y.; Electrically Welded Steel Pipe Lines, illustrated by lantern slides, Samuel Martin, Jr., Industrial Engineer, General Electric Company, Schenectady, N. Y.; Discussion—William Flannery, Mechanical Engineer, Department of Water Supply, Gas & Electricity, New York, N. Y.; J. F. Lincoln, President, Lincoln Electric Company, Cleveland, Ohio; E. E. Shanor, Petroleum Iron Works Company, Sharon, Pa.; F. H. Stephenson, Engineer of Water System, Detroit, Mich.; Notes on European Pipe Practice, R. H. Keays, Chief Engineer, Ulen & Company, Athens, Greece; Standard Practice in Steel Plate Pipe Lines, Discussion, W. W. Brush, G. W. Fuller, J. F. Laboon, A. V. Ruggles, F. H. Stephenson, T. H. Wiggin, F. E. Winsor.

2:00: Water Purification Division—Trends in Municipal Zeolite Water Softening, W. J. Hughes, Mechanical Engineer, and H. B. Crane, Principal Assistant Engineer, International Filter Company, Chicago, Ill.; Reduction of Carbonate Hardness by Lime Softening to Theoretical Limit, Charles P. Hoover, Chemist in Charge, Water Softening and Purification Works, Columbus, Ohio, and James Montgomery, Superintendent of Water Works, Piqua, Ohio; Zeolite Softening Plant Operating Experiences, D. E. Davis and J. T. Campbell, J. N. Chester Engineers, Pittsburgh, Pa.; Operating Experiences with a New Water Softening Plant at Marion, Ohio, illustrated by lantern slides, Martin E. Flentje, Superintendent of Filtration, Community Water Service Company, 46 Cedar Street, New York, N. Y., and Charles Whysall, Chemist in Charge, Marion Water Softening Plant, Marion, Ohio.

7:30: Dinner dance, informal.

Friday—9:00: General Session. New Developments in the Safeguarding of Cross Connections in New York State, C. A. Holmquist, Director, and Earle Devendorf, Associate Director, Division of Sanitation, State Department of Health, Albany, N. Y.; Mechanical Developments in Water Treatment Practice, C. T. Leander, The Dorr Company, Toronto, Ont., Canada; Steel Tanks for Water Works Systems, Geo. T. Horton, President, Chicago Bridge & Iron Works, Chicago, Ill.; Methods of Water Softening and Filtration, J. A. McGarigle, Permutit Company of Canada, Ltd., Toronto, Ont., Canada.

2:00: Joint Session Plant Management and Operation Division, and Superintendents' Round Table Discussion. Effect of Rigid Jointing Material on the Strength of Pipe Bells, W. W. Brush, Chief Engineer, Department of Water Supply, Gas & Electricity, New York, N. Y.; Cement Lining Small Iron Pipe—A Method Suitable for Small Utilities; illustrated by lantern slides, R. W. Reynolds, Superintendent, West Palm Beach Water Company, West Palm Beach, Fla.; Committee on Water Works Practice.

The usual method of registration will be in effect, registration cards being mailed to all members with a guest card. More guest cards can be secured by mail or at the registration desk. However, by ruling of the Executive Committee, each person registering, whether a member, guest or representative of a manufacturer, will pay a registration fee of $5.00. This will be collected at the registration desk at time of registering, and entitles attendants to tickets for all entertainment features.

The railroad passenger associations have granted the Association the fare and one-half rate for the round trip to the Toronto convention. This will be on the Identification Certificate Plan. Details regarding the purchase of tickets under this plan will be announced later. Identification certificates will be sent out to all members, entitling them to purchase railroad tickets at this reduced fare.

In addition to the many regular sessions of the convention, there will be held Monday night, June 24th, an informal reception and dance, and on Wednesday night there will be a smoker for the men and a theater party for the ladies. On Thursday night a dinner dance, informal, will be held, and various card parties, shopping tours, etc., will be given for the ladies on other days.

Excellent golfing facilities will be provided for those who can find time to play and feel so inclined, and a handicap tournament is being arranged.

The usual complete and interesting exhibit of the Water Works Manufacturers' Association members will be held, showing water works accessories and equipment.

New York State Sewage Works Association

At a meeting held at Albany, N. Y., May 4, a New York Sewage Works Association was formed with a membership of 83.

The objects of the Association are: 1. The advancement of fundamental and practical knowledge concerning the nature, collection, treatment and disposal of sewage and industrial wastes, and the design, construction, operation and management of works for the collection and treatment of these wastes.

2. The promotion and encouragement of improved waterways sanitation, through the same measures.

3. The encouragement of a friendly exchange of information and experience among its members, and other interested persons, by an annual convention of its members, the publication of proceedings of its meetings, affiliation with the Federation of Sewage Works Associations, and participation in the activities of that organization.

Any engineer, bacteriologist, chemist or other qualified person engaged in the advancement of knowledge relating to sewerage or sewage disposal, or connected with the administration or operation of sewerage or sewage disposal works, or a municipality of the State of New York, is eligible as an active member.

It is planned to hold quarterly meetings in different towns including an annual meeting in May at Albany.

The Association will affiliate with the Federation of Engineering Societies.

Officers were elected as follows: President, Kenneth Allen, New York City; Vice-President, C. A. Holmquist, State Department of Health, Albany, N. Y.; Secretary-Treasurer, E. S. Bedell, State Department of Health, Albany, N. Y.

An Executive Committee was elected: to serve 3 years: Earl Devendorf, C. A. Holmquist, J. F. Skinner; to serve 2 years: H. B. Cleveland, M. M. Cohn, Glenn D. Holmes; to serve 1 year: K. Allen, R. H. Gould, R. Sater.

Representatives on Board of Control, Federation of Sewage Works Associations: to serve 2 years, C. A. Holmquist; to serve 1 year, Kenneth Allen.

American Road Builders' Association and Road Show

The 1930 convention and road show of the American Road Builders' Association will be held at Atlantic City January 11-18.

The president's dinner and installation of new officers of the association followed a two-day meeting at Washington, D. C., of all association committees, divisions and the directorate. F. A. Reimer succeeded as president. R. Keith Compton, director of Public Works, Richmond, Va., who became a director. James H. MacDonald, New Haven, Connecticut, continues his years of service as treasurer and Charles M. Upham, Washington, D. C., continues as Secretary-Director. Other new directors are J. S. Helm, Standard Oil Company, New York, and Arthur W. Dean, Chairman, State Highway Commission, Boston, Mass. Charles E. Grubb, County Engineer, Wilmington, Delaware was installed as head of the County Highway Officials' Division, succeeding T. J. Wasser, Jersey City, N. J.

Atlantic City was chosen for the 1930 meeting after a long and vigorous fight on the part of Cleveland to have the road builders return there. Cleveland has entertained the past two gatherings. St. Louis also was a bidder for the meeting.

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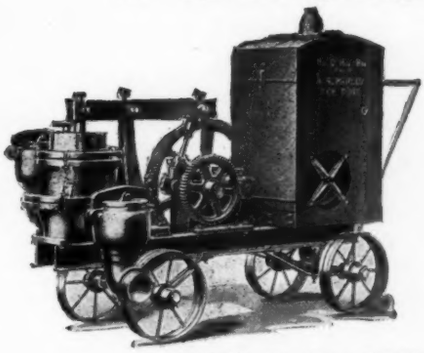
At Your Sewage Disposal Plant Use a

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OF THE PLUNGER TYPE
Made in 3" and 4" Sizes, Single or Double
Engine or Motor Drive
Bulletin 40 gives detailed specifications
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4241 Ravenswood Avenue, Chicago
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New England Water Works Ass'n.

The New England Water Works Association will hold its June Outing at the New Ocean House, Swampscott, Mass., on Tuesday, June 18, 1929.

The Committee in charge for the N. E. W. W. Ass'n are Patrick E. Kelly of the Leadite Company, C. A. Bingham, Town Manager, Norwood, Mass.; H. W. Dotten, Supt. Water Works, Winchester, Mass.

Personals

The O'Keefe-Orbison Engineering and Construction Company, Appleton, Wisconsin, has announced the expansion of its organization by the addition of two engineers who have also become officers of the company. W. H. Gmeiner, now secretary of the company, formerly was in charge of construction for Whitney-Stein Co., of Denver, Colo., and served as city engineer for Grand Junction, Colo., where he designed and built the municipal water plant. For the last ten years he has been plant manager of the Appleton Wood Products Company. His capacity with the O'Keefe-Orbison company will be that of architect and engineer. E. C. Nelson has been for the last three years assistant chief engineer for the Longview Fibre Company, Longview, Wash., and recently returned from the west to become a consulting engineer for the Appleton firm. Previous to that time he was connected with the engineering department of the Kimberly-Clark Corporation, Neenah, Wisconsin, and with James L. Carey of Chicago, Ill.

J. C. McVea, municipal improvements engineer, has opened an office in the Esperson Building, Houston, Tex., and will specialize in the practice of sub-division developments and city planning.

Civil Service

Draftsman.— The United States Civil Service Commission announces the following open competitive examinations: Detail draftsman (mechanical), $189.00 a month; engineering draftsman, $187.50 a month; assistant engineering draftsman, $168.75 a month; junior engineering draftsman, $150.00 a month. Applications for these positions must be on file with the Civil Service Commission at Washington, D. C., not later than June 5. The examinations are to fill vacancies in the Panama Canal Service, and in positions requiring similar qualifications. Competitors will not be required to report for examination at any place, but will be rated on

their education, experience, and fitness, and specimens of drawings and lettering to be filed by the applicant.

Bacteriologist—Applications must be on file with the Civil Service Commission at Washington, D. C., not later than July 3. The examination is to fill a vacancy in the United States Public Health Service, Honolulu, Hawaii. The entrance salary is $4,000 a year. The duties are to carry on bacteriological investigations and research on matters pertaining to the public health. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness, and on publications of a thesis filed by the applicant.

Junior Engineer and Deck Officer.—Applications must be on file with the Civil Service Commission at Washington, D. C., not later than June 26. The examination is to fill vacanies in the United States Coast and Geodetic Survey, at the entrance salary of $2,000 a year, and in positions requiring similar qualifications. Applicants must have completed at least three and one-half years of a course in civil engineering or a course in geodesy and surveying leading to the degree of C. E. or B. S., in a college, university, or technical school of recognized standing, but graduation with one of these degrees, with the completion of at least 118 semester-hour credits, will be required before appointment.

Mechanical Engineer.—Applications must be on file with the Civil Service Commission at Washington, D. C., not later than June 19. The examination is to fill vacancies in the position of Chief of Mechanical Service, U. S. Penitentiary Service, Atlanta, Ga., and Leavenworth, Kansas, and vacancies occurring in positions requiring similar qualifications. The entrance salary is $3,800 a year.

The duties are to review and approve plans for construction involving mechanical installations of any character, and to prepare all specifications for mechanical equipment or appliances; to have immediate supervision over the maintenance and operation of a power plant, and to direct all maintenance, operation and repair work pertaining to the mechanical equipment in the institution; to be associated with or supervise the work of the instruction foreman as designated, and to perform related work as required.

Competitors will not be required to report for examination at any place, but will be rated on their education, experience, and fitness.

Information.—Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

Book Reviews

Plumbing Questions and Answers.—By Joseph E. Taggart. 164 pages, 30 illustrations. Scientific Book Corp., N. Y. Price $2.

This little book contains much useful information for master and journeyman plumbers, sanitary engineers, plumbing inspectors, architects, estimators and draftsmen. It is based on the rules and regulations of the City of New York.

Proceedings, American Road Builders Association. — Illustrated. 582 pages. A full account of the papers and discussions at the various sessions of the 26th annual convention held at Cleveland.

The Ideals of Engineering Architecture.—By Charles Evan Fowler. 295 pages, illustrated. Gillette Publishing Co., Chicago. Price $4.

This book considers in a most interesting and pleasing way a subject which heretofore has received comparatively little attention. In Chapter II, it is pointed out that too many engineers pay little attention to anything but the utilitarian aspects of their work. This is true, yet there has been a notable advance during the past few years in the realization that good design covers appearance as well as usefulness.

In his opening chapters, the author reviews and discusses the basic principles, and their harmonization in aesthetic design. Simplicity, symmetry, harmony and proportion are stated to be the four fundamentals to be observed. In later chapters, the design (from the viewpoint of aesthetics) is discussed of stone, concrete and steel arch bridges; suspension, cantilever, draw and truss bridges and viaducts; abutments, piers, and towers of stone and steel; and retaining walls, dams, tunnel portals and power houses.

While structures only are discussed in this book, every engineer ought to study it, for the principles discussed apply just as fully to the design of many other engineering works.

Trade Publications

"100 and 1 Ways to Save Money With Portable Compressors." — This seventh edition of Ingersoll-Rand's book contains a number of interesting features not embodied in former editions. Its 144 pages include 24 full-plate illustrations, about 300 smaller pictures, and over 100 tables of accurate construction data. The cost figures, being on the man-hour basis, apply to conditions in all sections of the country; for, though wage rates differ, the same labor-saving methods prevail throughout. These figures are authentic, and show clearly how many contractors, public utilities, industrial concerns, and railroads are saving on their labor costs.

Tree Moving—The Caterpillar Tractor Co., San Leandro, Calif., and Peoria, Ill., has just issued a folder on the subject of tree moving. Successful methods employed by famous park superintendents and practical landscape gardeners are pictured and explained in this folder, which will be sent free on request.

Steel Poles.—A book of engineering and technical data on "Truscon Weltrus Steel Poles" has just been published by the Truscon Steel Company of Youngstown, Ohio. It presents the new Weltrus Steel Pole as a carefully and accurately engineered product in a price field which makes it a competitor of wood poles. The Weltrus Pole is manufactured in standard lengths up to 65 feet. Complete engineering tables and detailed drawings of pole construction are included in the book for the convenience of officials and engineers who may be contemplating construction of transmission lines. Data on pole fittings and accessories, as well as descriptions of Weltrus and Z-type poles are included.

Concrete Bridges—The Portland Cement Association, 33 West Grand Avenue, Chicago, has published an attractive and well illustrated booklet, "Concrete Bridges," for distribution among engineers, civic and town councils and chambers of commerce where bridge construction is under consideration. The booklet presents a discussion of some of the principal requirements of bridges, and how these may be met economically and efficiently. Maintenance, economy and structural details of incidental parts as well as a plain discussion of the material "concrete" and the factors relative to its successful manufacture are among the subjects treated. The illustrations have been chosen to show the possibilities of concrete for bridges of any length or for single spans of from 20 to 300 feet and longer.

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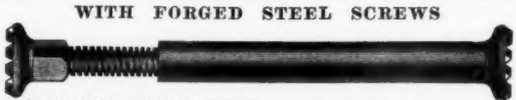
WITH FORGED STEEL SCREWS
Complete Stock

Prompt Shipment
WRENCH FREE WITH EVERY TWO DOZEN
Not excelled for narrow and medium width trenches. Mud guards desirable where concrete or mud hardens on braces. **The only brace that is free from projections that hinder workmen in the ditch.** Kalamazoo timber brace fittings are suitable for wider trenches.
KALAMAZOO FOUNDRY & MACHINE CO. 570 East Main St. Kalamazoo, Mich.

THE SMALL VILLAGE ALSO WELCOMES IT!

VITRIFIED brick pavement, in ever-growing demand for the large cities and main highways, is especially ideal for the small community. For it not only assures long service with practically no maintenance, but it requires neither a highway organization nor expensive facilities.

Rosehill Avenue, one of the beautiful residential sections of Cincinnati. Aside from long life and low cost, brick pavements add charm and individuality to any community. For further information on brick pavement address, National Paving Brick Manufacturers Association, National Press Bldg., Washington, D.C.

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Engineering and Construction Equipment

New Machinery, Apparatus, Materials and Methods and Recent Installations.

New W & T Main Sterilizer

Wallace & Tiernan Co., Newark, N. J., will exhibit for the first time at the annual meeting of the American Water Works Association at Toronto, a portable chlorinating equipment for sterilizing water mains and for emergency uses. This equipment is compactly arranged in two modern cabinets with a carrying handle on each. It is complete in all fittings and accessories needed to chlorinate by either the direct or the solution method and for making the necessary residual chlorine tests for control purposes.

One cabinet contains the chlorinator and the other, the accessories and testing equipment such as hose, flexible tubing, silver diffusor, chemical and testing bottles.

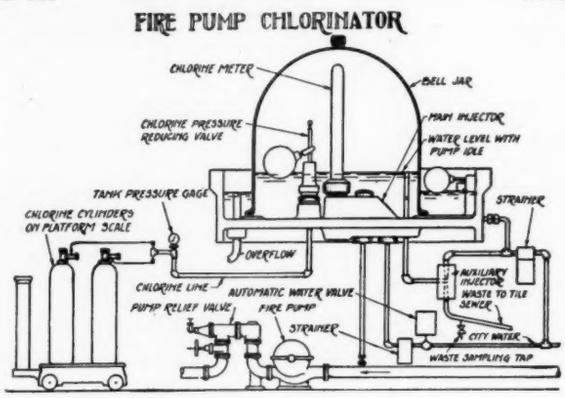
This equipment is developed to meet a growing demand on the part of water works officials for a portable chlorinator which could be used in the field for sterilizing new and repaired sections of water mains.

Research in the last few years has clearly indicated that by periodic chlorination of water mains, after growths and biologic deposits in the distributing system may be entirely eliminated. The equipment is adaptable for operation under any emergency conditions and is a valuable supplementary chlorinator for any water works.

Fire Pump Chlorinator

Wallace & Tiernan Co., Inc., Newark, N. J., have developed, in co-operation with representatives of the fire underwriters and the New York State Department of Health a new fire pump chlorinator. The equipment was designed to meet conditions in those industrial plants where it was found absolutely necessary to maintain a cross connection between the fire system from secondary source and the public water supply. Installations in New York State are in conjunction with Factory Mutual type double check valve.

The chlorinator used is the standard Wallace & Tiernan vacuum type solution feed equipment. A small auxiliary injector is provided which is operated continuously from the city water system, discharging to waste a small quantity of chlorine solution (one to two pounds per day). Operation at this low rate keeps the chlorinator in readiness at all times for emergency use when the fire pump is put in operation. Water from the fire system supplies the main injector of the chlorinator and automatically feeds chlorine to the fire pump supply at a predetermined rate to assure sterilization of the water. This rate of feed is constant. The chlorinator is set in accordance with specifications of the State Board of Health. This chlorinator is not sold for installation except under conditions approved by the State Board of Health.



W. & T. Fire Pump Chlorinator.

In practice the operation of the auxiliary injector is checked daily by testing for chlorine in the water discharged to waste. Weekly tests are required by the State Board of Health. Careful records are kept of the operation of the fire pump chlorinators.

This equipment promises to be a practical solution of the difficult health problem of assuring protection against local cross connection within industrial plants where of necessity a secondary fire water system must be provided for emergencies.

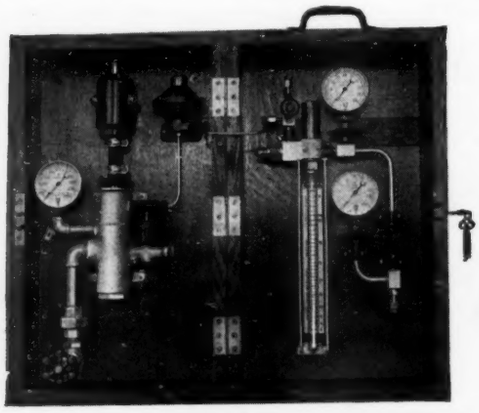
"Silver Seal" Protective Paint

The Asphalt Products Co., Syracuse, N. Y., have announced "Silver Seal" protective paint, which combines pitch and aluminum flakes. It is stated that "Silver Seal' 'is one of the outstanding developments of recent years as a wear-resisting, light and heat repelling, and moisture proof surface coating.

Actual tests made by the United State Forest Service at the Forest Products Laboratory, it is said, proved that pitch paint with an added coating of aluminum powder, possesses an efficiency against atmospheric moisture of 98%. In this instance, the coating required two distinct applications, first the pitch paint, followed by an application of aluminum powder.

In "Silver Seal," it is claimed, all the protective properties of pure pitch base liquid are blended with aluminum bronze powder to form a liquid applied in a single coat. "Silver Seal" is applied as other paints with brush or spray, but does not require particularly skilled labor for the operation. It is one of the most permanent and economical surface coatings and is obtainable at a cost no greater than that of pitch paint alone.

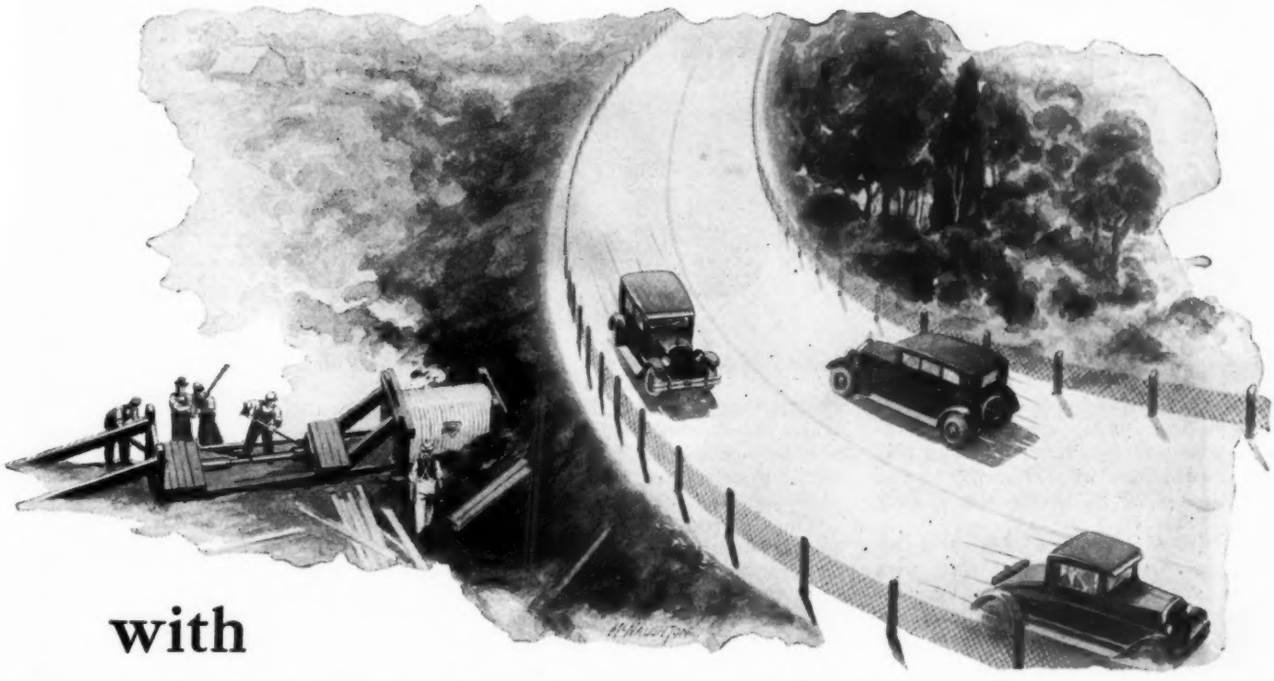
Aside from its economy, "Silver Seal" has no equal as a wear-resisting coat for exterior or interior surfaces. It will not peel, check or crack under any climatic conditions. Moisture, commercial acids, heat and rust can neither penetrate nor destroy any surface over which "Silver Seal" has been applied. It lightens dark corners; its light reflectivity assures a surface that is restful to the eye, and when used as an exterior coating its heat resistance maintains a uniform temperature at all times.



W. & T. Main Sterilizer.

W. & T. Main Sterilizer Accessories.

The Spending Public
kept on spending . . . .



with the Armco Jacking Method *the road was never closed!*

IT looked to us like a very difficult job. We had to provide a new culvert under the main road into a nearby town. The usual open trench and detour would seriously cut business for the local merchants in favor of a nearby city — the situation was "ticklish" to say the least. ¶Thanks to the Armco Jacking Method the culvert is now in place without an hour's loss of the use of the road . . . "the spending public kept on spending." ¶It will pay anyone who needs an additional opening under an existing road to investigate the Armco Jacking Method. There is no longer any need for expensive open trench and costly detours. The assistance of Armco engineers is available to you on every Armco culvert job. They have valuable data gathered from many years of field experience, not obtainable from any other source.

Armco culverts and drains are manufactured from the Armco Ingot Iron of the American Rolling Mill Company and always bear its brand

ARMCO CULVERT MANUFACTURERS ASSOCIATION
Middletown, Ohio

ARMCO CULVERTS

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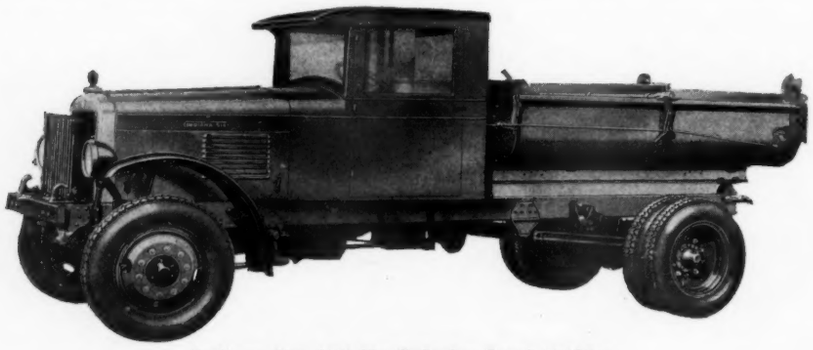
Indiana Model 627AW Road Builder

The Indiana Truck Corporation, Marion, Ind., has brought out the new model 627AW—6 cylinder chassis, which carries a rating of 20,000 lbs. permissible maximum gross weight of truck and load.

The wheelbase of this new model is 156¼ inches with length back of driver's seat of 8 ft. 4 inches. The



Indiana 627 AW Six-Cylinder Road Builder.

engine is a Wisconsin Model "H," valve-in-head type, six cylinder, 4-inch bore and 5-inch stroke, with piston displacement of 377 cubic inches, and developing 72 horsepower at only 2000 R.P.M.

A full floating type, double reduction gear drive rear axle is used, with mechanical service brakes on the rear wheels of the internal expanding type, operating by a vacuum booster, affording maximum braking facilities and very smooth operation. These brakes are 18 inches in diameter with 4-inch bands. The emergency brake is operated by a hand lever, this being a 14-inch diameter disc brake mounted on the propeller shaft.

The frame is a special heat treated, pressed steel stock with a breaking strength of 90,000 lbs. to the square inch. Transmission is of the unit power plant type, with five speeds forward and two in reverse. Standard is with fifth in direct, optional direct on 4th speed with 5th speed an overdrive.

The Indiana patented Tors-Elim 3 point suspension mounting of motor, radiator and cab is used on this model Indiana Road Builder.

The dump body equipment recommended for this model is an 81-cu. ft. steel dump body with straight sides and round bottom (square corners optional) with double acting tail gate and center partition for batch work. Width of body is 72 inches, standard length 102 inches, height 19 inches.

Lorain Gasoline Locomotive Cranes

The Thew Shovel Co., Lorain, O., has added 15 and 20-ton locomotive cranes to the Lorain 55, 60 and 75, 1 to 1¼ yard, crawler-mounted cranes to present a complete line of crane equipment.

Lorain cranes, mounted on car wheels or crawlers, are designed and built especially as gasoline locomotive cranes. Electric or diesel power plants are also furnished for the 15 and 20-ton locomotive cranes. Plug-in, trolley and third rail systems can be had for the electric powered units.

Thew Lorain cranes can hoist, swing and travel (2 speeds in either direction) or derrick the boom simultaneously with independent control over each operation. Such flexibility of operation and traveling is characteristic of the steam machine, yet the Lorain locomotive cranes offer the additional economies of 1-man operation and gas, electric or diesel power, especially valuable where intermittent service is required.

The 15 and 20-ton superstructures are the Lorain 60 and 75 superstructures, transferred with minor changes from the 2-speed center drive crawler mounting to a 2-speed, 8-wheel, double truck car body of ARA standard specifications. The 15-ton crane offers the flexibility feature of being readily transferable from car wheel to crawler mounting. Both 15 and 20-ton cranes can be equipped with all the standard boom equipment of the Lorain 60 and 75, including crane, clam and drag, the shipper shaft shovel and the backdigger booms.

Briefly, the Lorain-60 15-ton locomotive crane and the Lorain-75 20-ton locomotive cranes are equipped with 45 or 50-ft. booms for use with 1 and 1¼-yard clamshell buckets. Booms are in two sections with interchangeable boom heads and middle sections for various boom lengths. Other equipment includes a 45-inch electric lifting magnet, excited by plug-in system or by a 7½-K. W. generator belt driven from the crane motor.

Lorain Gasoline Crane.

The 8-wheel double truck car body is 24 ft. 2½ inches long over the couplers and is of ARA standard specifications. It is equipped with swivel outriggers and track clamps.

The car body has two travel speeds, 4.2 M.P.H. and 2.1 M.P.H. in either direction. Gear ratios can be varied to give other than standard speeds up to 14 miles per hour for main line railroad work. It is equipped with two hand travel brakes as standard equipment. One operates on the travel mechanism of the superstructure, the other acts on the truck body. Through air line is provided for shipment on train. As extra equipment both straight and automatic air brakes can be supplied, powered by an air compressor driven by the crane motor.

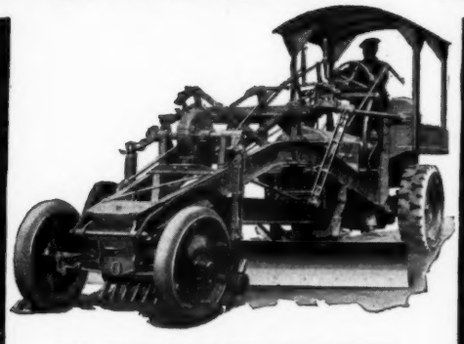
Krohn Truck and Automobile Differential

The Krohn Differential Corporation, Chicago, Ill., manufacture the Krohn differential gear, which, it is claimed, allows one wheel to turn faster than the other in rounding a corner, permits one wheel to turn when jacked up, but does not let one wheel spin idly when driving on wet, muddy, snowy or icy roads.

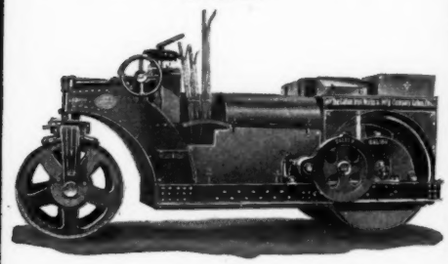
The differential action is obtained, when traction varies, by a difference in the number of teeth in the various gears, which permits the central gear to rotate about the other gears. This allows slight rotation of one driving wheel with respect to the other which is necessary when rounding corners. It does not, however, allow complete freedom of rotation of either driving wheel with respect to the other. And it is this fact which prevents wheel spinning and insures getting power to the wheel that has traction.

In operating a truck, tractor, bus or pleasure car, this action becomes automatic. The slightest tendency to slip is handled before it causes actual slipping. The flow of power is thus constantly directed to the wheel that can use it and it is claimed the truck becomes seemingly more powerful, shows greater gasoline mileage and goes up slippery hills and over stretches of ice or snow that could formerly be negotiated only with great difficulty, even with the help of skid chains.

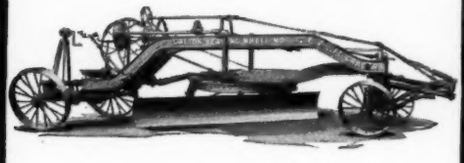
GALION ROAD MACHINERY



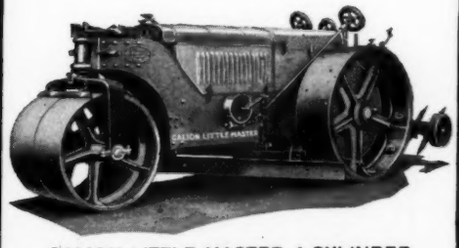
GALION E-Z LIFT ONE MAN MOTOR GRADER



GALION 4-CYLINDER MOTOR TANDEM ROLLER. 5 TO 10 TON



GALION E-Z LIFT ADJUSTABLE LEANING WHEEL GRADER



GALION LITTLE MASTER 4-CYLINDER MOTOR ROLLER 6. 7 OR 8 TON

GALION MASTER 4-CYLINDER MOTOR ROLLER. 10 OR 12 TON

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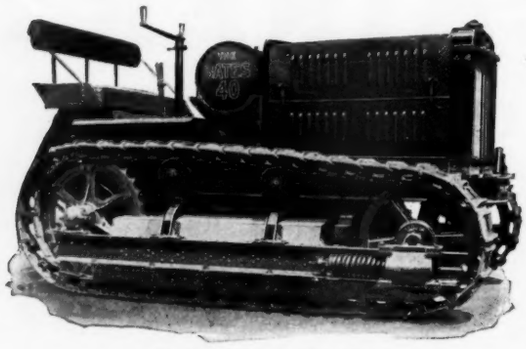
GALION ROAD MACHINERY
WILL SERVE YOU BEST

The World's Largest Road Machinery Plant

La Plant-Choate Sidewalk Snow Plow

The La Plant-Choate Mfg. Co., Cedar Rapids, Iowa, has recently brought out their Model 5-10 Sidewalk plow for use with the Caterpillar "Ten" tractor. This plow opens up a full 5-foot width in one trip through, and the sidebank thrown up is sidesloped to prevent the snow from falling back on the sidewalk.



The Bates "40" Tractor.

By mounting the lifting scaffold in the center of the track frame it puts the weight where it does not cause bobbing or have a tendency to cause the tractor to nose-dive. The center of the track frame is the center of balance on the tractor and the point least affected by the rise and fall of the tractor. This point from which the plow is pushed furnishes a relatively constant push point.

The hooked runner with a removable half sole serves three purposes. It carries the weight while plowing and prevents digging in. It has a hook in front which lifts the plow over uneven spots in the sidewalk, obstacles, etc. This feature eliminates the constant winding and lowering of the plow in passing over obstructions.

Side-draft is successfully counteracted by using a landside on one side and an overhanging delivery point on the other. These features make it possible for the plow to go straight down the sidewalk without continual use of the clutches on the tractor.

The chisel edge shape on the blade enables it to cut under the snow and shave the snow off close to the walk. The roll then lifts and rolls the snow upward and outward with a minimum of effort.

The same lifting scaffold and pushframe is used on both the bulldozer and the sidewalk snow plow T-10 and either blade may be changed in a few minutes. Thus the tractor may be used for bulldozer work one day, and be available almost instantly for snow removal work by simply changing blades.

Bates "Steel Mule" Tractors

Foote Bros. Gear & Machine Co., Chicago, Ill., manufacture the Bates "Steel Mule" tractors, which are claimed to possess an unusual amount of traction. They are built broad and low, giving added stability in side-hill work. Other advantages of the Bates tractors include easy handling, economy of operation, flexibility and an easily detachable one-piece track shoe.

The "30" is the smallest of the Bates tractors. It is stated to be able to handle an 8-foot grader with ease and has more than sufficient power to do ordinary road and maintenance work. It weighs about 8,750 pounds. The "40" handles a 10-foot grader easily and has the necessary power economically to handle all the usual road work for counties, states or townships, and will push snow plows and bull-dozers. It is rated at 40 horsepower and weighs about 12,500 pounds. The "80" handles 14-foot graders and is suitable for work in all branches of heavy tractor service. It weighs about 22,500 pounds.

Model T-10 La Plant-Choate Hand Operated Bulldozer

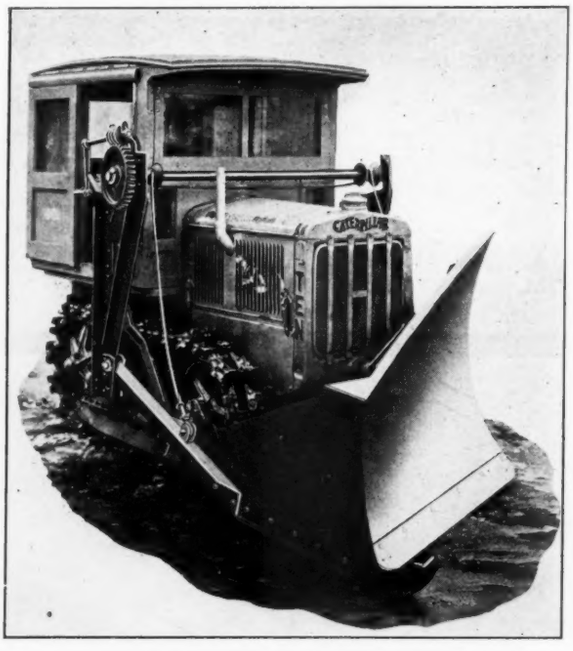
The La Plant-Choate Mfg. Co., Cedar Rapids, Ia., has brought out the T-10 hand operated bulldozer for use with the Caterpillar "Ten" tractor.

The size and mobility of this tractor makes it an ideal power unit for use on the lighter bulldozer operations such as backfilling small trenches, bulldozing refuse and ash piles around industrial plants and for filling in low spots on sub-division work. The size of the tractor with the bulldozer attached makes it possible to load the entire unit on any ordinary truck and transport it to a new location quickly.

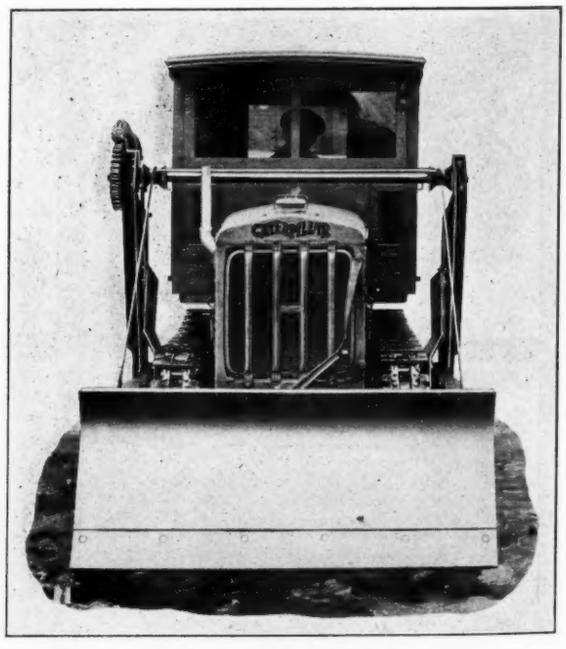
This unit is also a most practical tool for any city to own. It may be used on the city dump, aviation field, sewer or water trenches, parks and golf courses, road work in the summer and for bulldozing snow into man-holes or around corners and drive-ways in the winter.

The lifting scaffold used on this bulldozer is also used on the La Plant-Choate sidewalk snow plow. The sidewalk plow blade and the bulldozer blade are interchangeable. This feature makes it a unit indispensable to cities, towns, and industrial plants.

The drawbar on the tractor is always in the clear with the bulldozer attached, thus making the tractor available for any hauling requirement at all times.

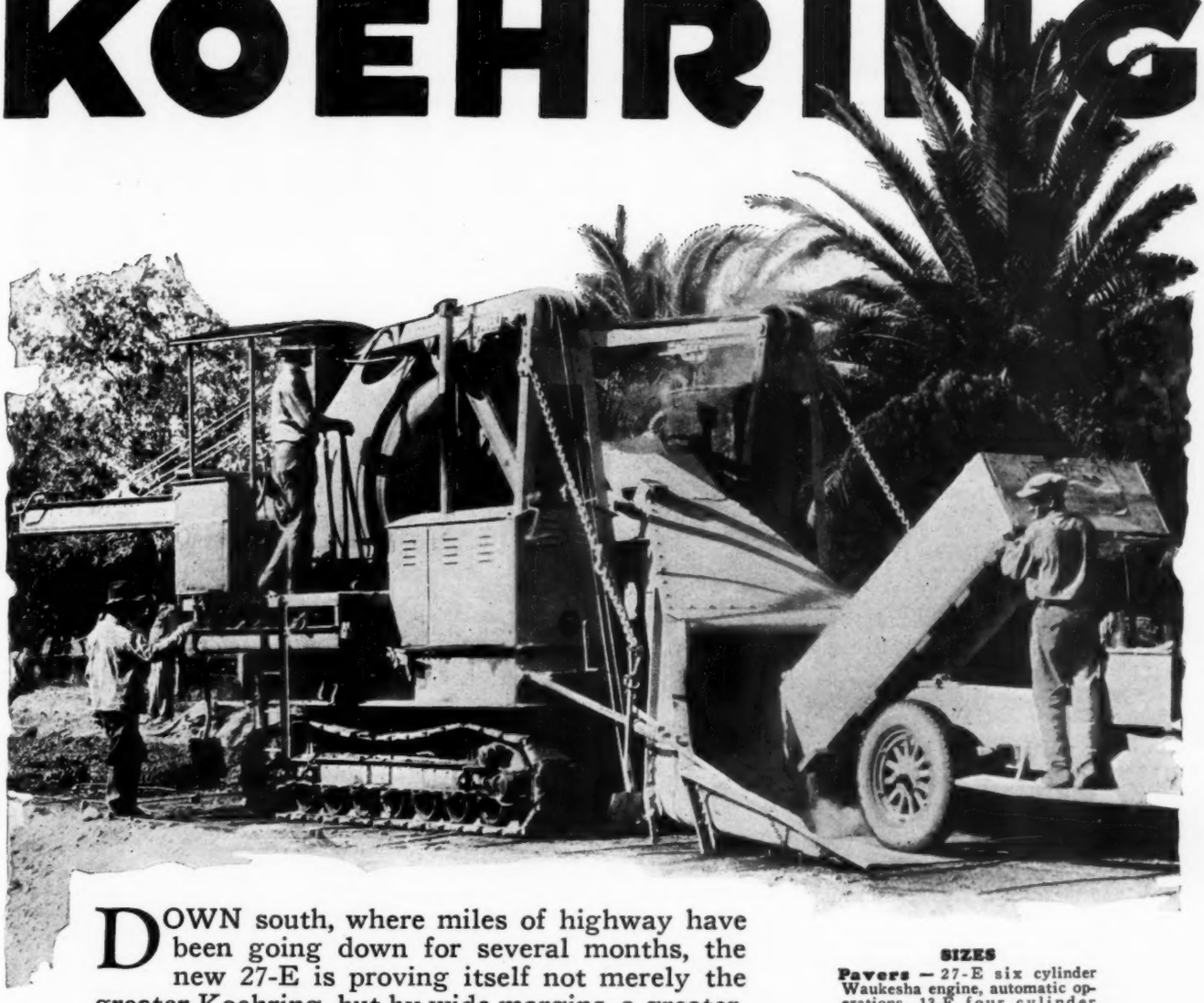


La Plant-Choate Sidewalk Plow.



La Plant-Choate Bulldozer.

The Greater KOEHRING



DOWN south, where miles of highway have been going down for several months, the new 27-E is proving itself not merely the greater Koehring, but by wide margins, a greater, faster money-making paver!

When haulage can keep pace with complete autocycle operation—the discharge starts, skip goes up, discharge chute reverses to mixing position, water and materials go into drum, and water shuts off—all automatically, on the split second! Operator merely lowers charging skip! And when haulage cannot keep pace with autocycle he merely raises as well as lowers skip with no further impairment of fast automatic speed!

Know the Greater Koehring 27-E!

Write for Bulletin.

SIZES

Pavers — 27-E six cylinder Waukesha engine, automatic operations. 13-E four cylinder Waukesha engine. Comply with A. G. C. standards.

Subgrade Planers — Built for all types of roadway, 8′ to 27′ widths; attachable to 27-E Paver.

Construction Mixers— 14-S, 21-S, 28-S. Trucks or skids; rubber tires optional. 28-S skids only. Weigh Mix attachments on 14-S. Comply with A. G. C. standards.

Dandie Mixers—5-S, 7-S, 10-S. 5-S single cylinder, 7-S two or four cylinder, 10-S four cylinder gasoline engine. Charging skip or low charging hopper and platform. Rubber tired or steel rimmed wheels. Comply with A. G. C. standards.

Division of National Equipment Corporation

KOEHRING COMPANY MILWAUKEE, WISCONSIN

PAVERS, MIXERS—GASOLINE SHOVELS, PULL SHOVELS, CRANES AND DRAGLINES

Sales Offices and Service Warehouses in all principal cities

Foreign Department, Room 579, 50 Church Street, New York City

KOEHRING HEAVY DUTY K E C

A 5194-I

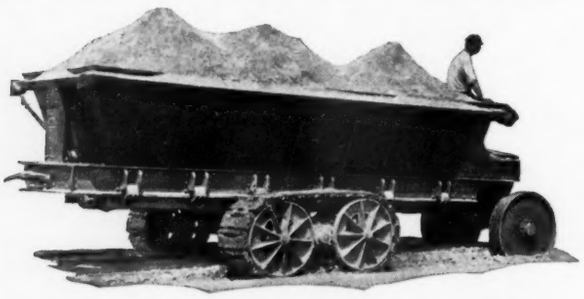
Creeper Wheels

The Creeper Wheel Co., Reading, Pa., manufacture creeper wheels in 4, 6, 10 and 15-ton capacity for attachment to wagons of all types for hauling over soft marshy or difficult soils. Creeper wheels are of the track-laying type, built to creep over rough spots or soft soils. They lay their own tracks and so are not dependent on roads.

Creeper wheels are stated to possess extreme flexibility, and to be practically non-friction and non-clogging, making the handling of heavy loads possible with a minimum of power. They have a minimum number of wearing parts, intermediate rollers, guides and sprockets having been eliminated in the design.

"Good Roads" Cold Application Oil Distributors

The Good Roads Machinery Co., Inc., Kennett Square, Pa., has brought out a cold oil distributor which is adaptable for mounting on small capacity high speed trucks. The elimination of the flues, oil burners, lagging, warming attachments, etc., reduces the weight and number of fittings necessary, and makes possible a considerable reduction in cost.



10-Yard Creeper Wheel Dump Wagon.

The tanks are of light gauge tank steel. The shell is in one piece with but one longitudinal seam. There is one interior baffle plate to take care the surge of the oil in the tank. There is also a 16-inch diameter dome fitted with flanged cover and gasket with handles and quick opening device.

The distributor unit is of the pump pressure type, pumping the oil direct into the discharge pipes under pressure. The capcity is 200 gallons per minute at 375 R.P.M., the suction opening is 3-inch, and the discharge is 2½-inch iron pipe size. There is a flanged three-way cock at the bottom of the distributor tank that permits pumping either from the tank itself or from the tank car.

In the piping system of these distributors, flanged fittings with wire inserted asphalt gaskets are used throughout, which makes a leak-proof distributing system and one that is self-draining. The entire system is protected by a patented combination relief, check, and control valve.

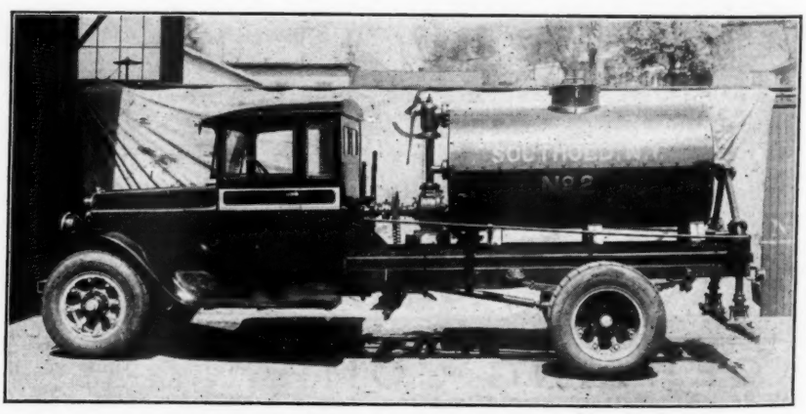
If a two or three-speed power take-off is furnished, the available pump speeds are ample for all conditions that the cold oil distributor may be subjected to and it will be capable of spreading from 1/10 to ¾ gallons per square yard. A split sprocket on the pump shaft is standard equipment and in case only one speed is available through the power take-off, a larger or smaller sprocket may be put on to obtain the desired speed and quantity in application. This change would require less than one-half hour.

The 500 gallon distributor empty weighs 2550 lbs. and the 600-gallon distributor empty weighs approximately 2750 lbs. The weight of 500 gallons of asphalt road oil is approximately 4000 lbs., and of 600 gallons, 4800 lbs. Therefore this extremely light weight outfit is adaptable to 2½ and 3-ton high speed trucks. It is only necessary that the truck shall be equipped with a suitable power take-off. A single speed will do, but a multiple (2 or 3) speed is much more desirable.

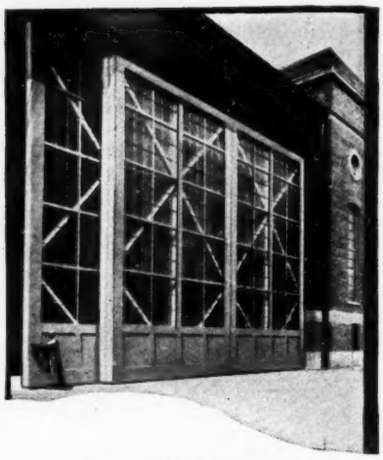
The mounting of the unit is a very simple job and can be done at the factory or by the customer. The unit is mounted on the truck chassis by means of U-bolts and it is not necessary to drill or alter the truck frame in any manner, as all controls, connections, and fittings are so constructed that they make a unit in themselves and do not fasten to or interfere with the frame.

The standard equipment includes one 8-foot standard aluminum manifold with snap connections, one complete set of fan-shaped spray nozzles (20), and one 15-foot length of 3-inch metallic flexible suction hose with tank car coupling. Extensions for the standard manifolds can be had at slight extra cost up to 12 feet. Manifolds 14 feet and longer can also be made up on request.

As an added feature for early spring and late fall road oil application, steam coils can be installed in the tank for slightly preheating the heavier of the so-called "cold" oils.



Good Roads 500-gallon Champion Cold Oil Distributor.



Truscon Hangar Door.

This outfit is equipped for "one man control," as all control levers are located right back of the driver's seat and can be operated by the truck driver through the rear window of the truck cab.

Airplane Hangar Door

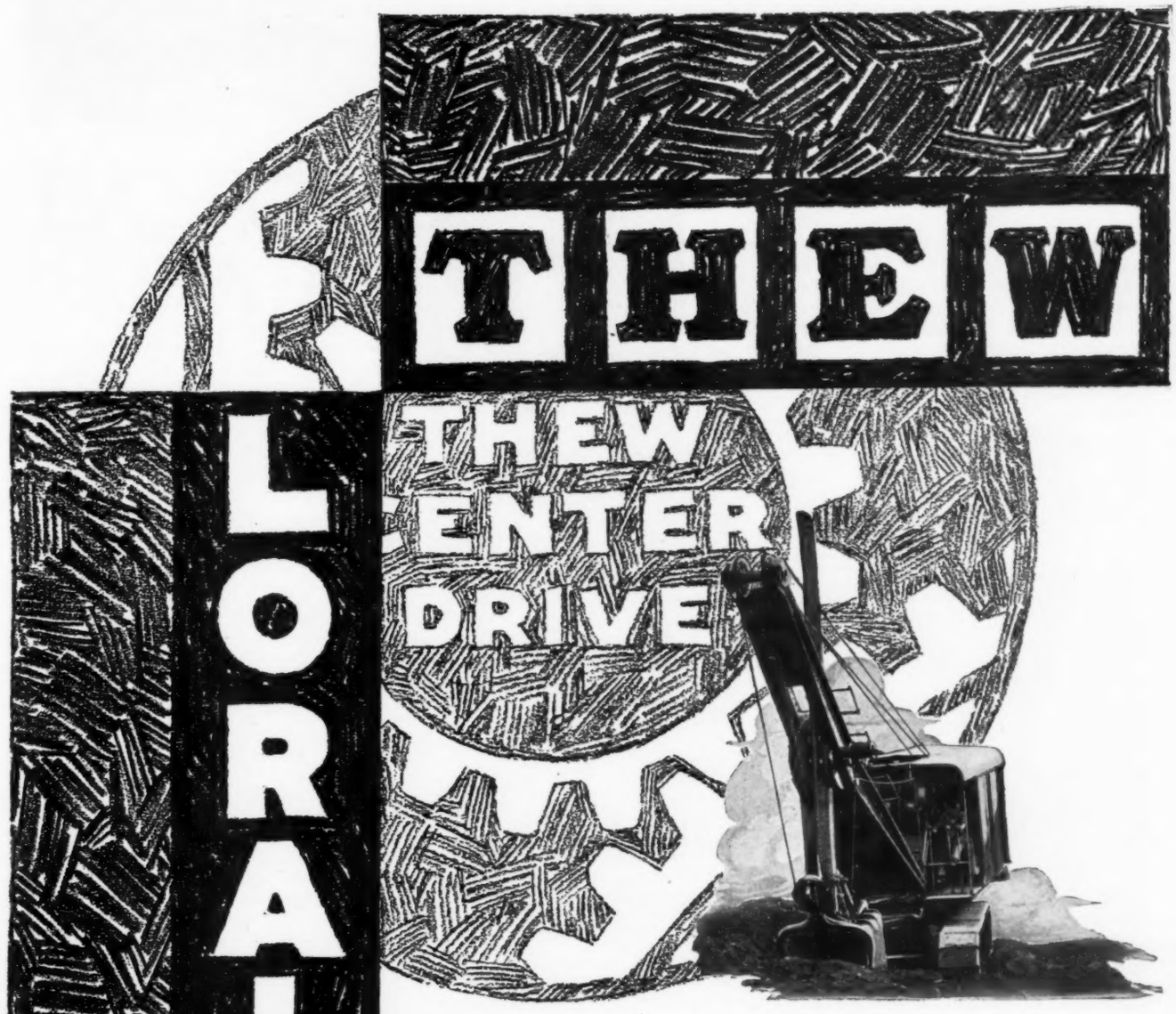
A special door for airplane hangars in which limited space is available for operation of the door units in opening and closing has been developed and is being manufactured by the Truscon Steel Company of Youngstown, Ohio.

This door is applicable to any kind of hangar construction, and may be used on any size of door opening.

The frame of the door is of heavy gauge tubular copper alloy steel, mitred and reinforced at the corners and electrically welded at all joints, or, if preferred, structural steel shapes may be substituted for the tubes in the door frame.

The lower sections are solid steel panels made from cold-rolled copper alloy sheets, full pickeled, reannealed and patent leveled. Any desired area may be built of standard steel window sections to permit adequate daylighting of the hangar. The door design is in harmony with recognized architectural practice, thus giving to the building a unified and effective exterior.

Truscon hangar doors are not suspended from overhead tracks, but are equipped with Timken roller bearing



ALL Lorain machines are built according to a distinctive Thew design—the Center Drive.

This is what enables the operator to throw all the power to any one operation—hoist, swing, or crowd. The 2-speed Center Drive Crawler, averaging less than $30 per year to maintain, gives Lorain machines mobility at low cost. And the Center Drive boom gives them the greatest working ranges of any shovels with equal length boom and dipper stick.

Thew owners all over the world will tell you that the Center Drive design means profitable operation of a shovel, crane, dragline or backdigger.

THE THEW SHOVEL COMPANY · *Lorain, Ohio*

Shovels · Cranes · Draglines · Backdiggers · Locomotive Cranes

Gasoline, Diesel, Electric and Steam Power

trucks operating on tracks embedded in the concrete floor.

These doors are made to operate in either of two manners. Many of the most modern hangars, including the one at Bettis Field, McKeesport, Pa., the Canadian Colonial Airways hangar at Albany, N. Y., and the Newark, N. J., airport hangar use straight slide doors which, when opened, disappear into towers or other auxiliary portions of the hangar structure.

Round-the-corner doors, which fit snugly against the sides of the hangar near the opening, are used in the U. S. Air Service Assembly building at Wright Field, Dayton, Ohio, on the N. A. T. hangar at Chicago and on many other structures. They are preferred where the plan of the building does not provide space for the opening of the straight slide doors and where there is no objection to narrowing slightly the door opening by storing opened doors at the sides.

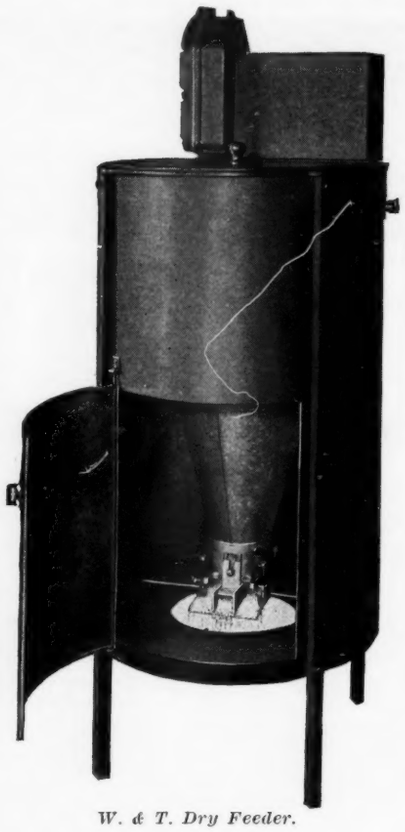
New Gasoline Hoist

The American Hoist & Derrick Company has brought out a newly designed gasoline hoist. This new hoist is powered with a Waukesha gasoline motor; the power is transmitted to the hoist by means of a silent chain drive and is delivered to what would be the crank shaft on a steam hoist; the logical place to apply the power. This company also makes the "American" two-speed drag scraper hoist. Mounted on a five ton motor truck this hoist constitutes the power plant of a useful and highly portable dragline installation.

Wallace & Tiernan New Chemical Feeder

Wallace & Tiernan Company, Inc., of Newark, N. J., have just announced their latest dry chemical feeder known as type "O." This feeder, which is the product of five years extensive study and research has many novel features.

Designed essentially as a low capacity feeder it has an unusually wide operating range and may be used for either fine or relatively coarse chemicals. The minimum rate of feed averages 0.1 pound per hour for all chemicals. The maximum varies from 40 to 80 pounds per hour depending on the chemical handled.



W. & T. Dry Feeder.

Perhaps the most novel features of design are the flexing mechanism of the hopper, the oscillating spout and the convenient, accurate adjusting mechanism. The sides of the hopper are flexed by means of levers near the top which alternately pull in and push out the sides. This method of agitation, positively prevents arching and keeps the contents of the hopper moving downward. A vertical agitator is provided for use with light chemicals.

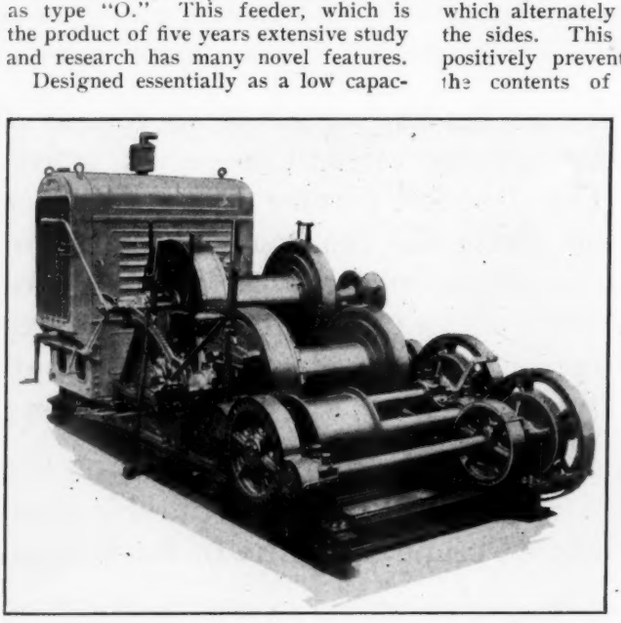
The discharge from the oscillating spout is in the form of a ribbon and the rate of discharge is determined by the length of ribbon pushed off the feed plate at each stroke of the spout. The spout stroke is regulated by a hand wheel having a 100 division circular scale. This long scale, which makes two revolutions in covering the full feed range, makes adjustments easy and accurate. In addition to the spout stroke adjustment the cross section of the chemical ribbon may be varied.

The equipment is operated by a 1-6 hp. motor. The gear case is completely enclosed. The gears run in a bath of oil. Bearings exclusive of the gear case, are fitted with special felt washers to keep oil in and dust out. The equipment is enclosed, and is thereby dustproof. It is adaptable for overhead feed with either direct or solution discharge to the point of application. When solution feed is desired a circular solution pot is provided. The water enters the pot at a tangent and the solution is discharged through a central over-flow outlet. High velocity and violent agitation makes the chemical solution with a minimum of water. Baffles are provided to prevent flooding.

Red E Power Lawn Mower

The Modern Machine Works, Inc., 189 Milwaukee St., Milwaukee, Wis., manufacture a simple and easy working power lawn mower. Exclusive features are stated to include exceptionally high reel clearance which permits cutting tall grass and prevents clogging; safety disc clutch which safeguards against damage when sticks and stones are encountered; a 4-cycle, air-cooled motor which operates efficiently with little consumption of gas and lubricating oil.

There are no gears; a chain drives the reel from the clutch shaft, which is joined to the motor by a flexible coupling. Speed is instantly controlled by



American Gasoline Hoist.

Model A Power Lawn Mower.

PLANTING A ROAD

A completely motorized job. One Sixty pulls a Russell elevating grader filling track-type dump wagons pulled by other "Caterpillar" Sixtys. The work *moves*. And when the road is finished these "Caterpillar" track-type tractors will maintain it—repair it in spring, clear it of snow in winter, pull the scraper, the scarifier—push the bulldozer or snow plow with sure-footed ease. Here is traction for soft spots and sand—power galore. There is a "Caterpillar" dealer near you. Ask him.

Prices—f. o. b. Peoria, Illinois

TEN	$1125	TWENTY	$1975
FIFTEEN	$1500	THIRTY	$2475
	SIXTY $4300		

Caterpillar Tractor Co.
EXECUTIVE OFFICES: SAN LEANDRO, CALIFORNIA
Sales Offices: Peoria, Illinois • 50 Church St., New York • San Leandro, Calif.
Holt Combined Harvesters • Russell Road Machinery
"Caterpillar" Tractors

CATERPILLAR
REG. U.S. PAT. OFF.
TRACTOR

This "Roadster" model 3½-ton Coleman features a low mounted Wood Type W-8 Body to facilitate easy loading.

a throttle conveniently located at the top of the handle. A slight turn of the handle grip starts or stops the mowing. Cushioning the handle takes up the shock and allows mowing with greater ease.

It is claimed that by the use of the patented clutch control handling is very easy, and that one man can cut three to six times as much as with a hand mower.

The Model A which has a 20-inch cut is powered with a 1 hp. air cooled motor. It weighs 190 pounds and has a cutting capacity of 2½ to 3 acres per day. It consumes ½ gallon of gasoline in 6 hours under average mowing conditions.

A Steel Roof Decking

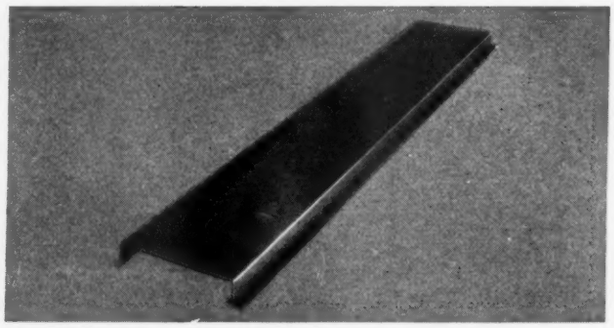
The Truscon Steel Co., Youngstown, O., has brought out Ferrobord, a new steel roof deck in six-inch wide units, which may be used as the base for any desired amount of insulation and for waterproofing materials. It provides as one of its features a positive attachment of the insulation material to the steel.

The new roof material presents a permanent surface of unbroken smoothness for the application of insulation. Each six-inch strip is rigidly locked to those on each side of it by a patented groove and flange formed on the strips thus forming a mechanically integral unit which is rigid over the entire roof area.

Another feature of the new product is that the strips are spliced by butt joints which may be made at any point without reference to supporting members. These joints are practically invisible from underneath. This characteristic of Ferrobord makes possible the utilization of short pieces cut off in fitting strips to the roof dimension. The strips may run either way of the roof, depending on which method of application is the more economical.

A specially designed and patented cleat is used to anchor the insulation to the steel on steep pitched roofs rendering slippage or creeping of the insulation impossible. These cleats are applied without perforations in the steel. In fact, the entire installation is without penetrations of the steel, thus increasing the efficiency of the insulation and giving positive protection against seepage of waterproofing materials.

Ferrobord comes in strips of any desired length, the only limitations being those imposed by shipping facilities. The deck may be used on any shape of roof.



Ferrobord Steel Roof Decking.

Cincinnati 1200 Series Gasoline Locomotives

The Locomotive Division of The Cincinnati Car Corporation, Cincinnati, Ohio, is announcing its new 1200 Series gasoline powered, gear driven, industrial locomotives that embody numerous improvements in design and construction to bring about both greater simplicity and durability, as well as better performance. These are also strongly reflected in the ease of operation and servicing, and in faster handling and continuous service.

Four starting and traveling speeds, both forward and backward, are provided so that with the liberal amount of engine power provided, through variation in throttle, or engine speed, very marked flexibility in speed and performance is possible.

To insure long life and proper functioning of the engines, they are provided with oil purifier, gasoline strainer and temperature gauge, the latter being mounted on an instrument panel in the cab with gasoline gauge, oil gauge, ammeter, and the different switches for control of ignition, lights and starting equipment. A spray-pump primer is also provided to assist in starting in cold weather.

A very large water capacity is provided in an over-size radiator and the engine, to afford the proper cooling of the engine in hot weather or hot climates.

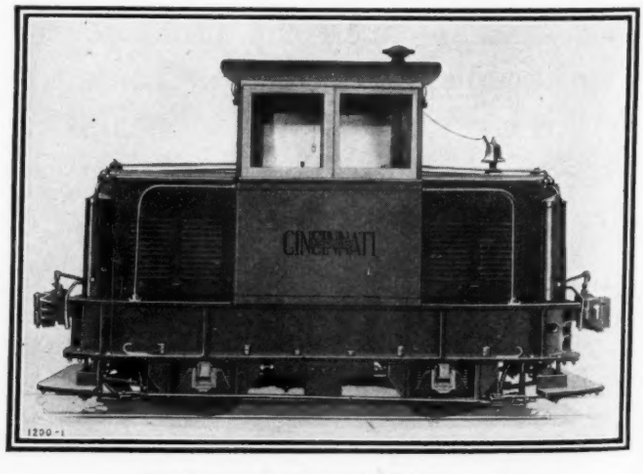
The drive wheels are located inside the main frame so that the axle bearings are on the ends of the axle, instead of behind the wheels, to afford the greatest convenience in lubrication and inspection of the bearings.

The amidship type of cab used not only affords the best possible vision in every direction but also permits of direct hook-up or connection of the operating levers and controls instead of through a series of rods and bell cranks. This makes a much more substantial construction of these parts as well as eliminating lost motion through wear on a large number of parts. On all models, the cab is wide enough to permit good vision alongside of cars, either ahead or behind, and high enough to see over the top of large industrial cars.

A valuable feature is that the operator handles all levers and controls with his right hand instead of his left hand, and the clutch with his left foot, both going forward and backward. Thus all movements are naturally made the same as in the average automobile or truck. The operator can also operate the automatic car-couplers at either end of the locomotive without leaving his seat, thus often saving much time in waiting on the brakeman to carry out these operations.

Effective hand brakes are provided either with or without air brakes. Air brakes are optional on all models, but can be furnished for operating on the locomotive alone, or the locomotive and cars together, and this can be done on models as small as 8-ton.

The different models in this series are all built in a variety of sizes and track gauges, and adapted for handling either industrial cars or railroad cars, and are recommended for any service where track haulage of any sort may be employed.

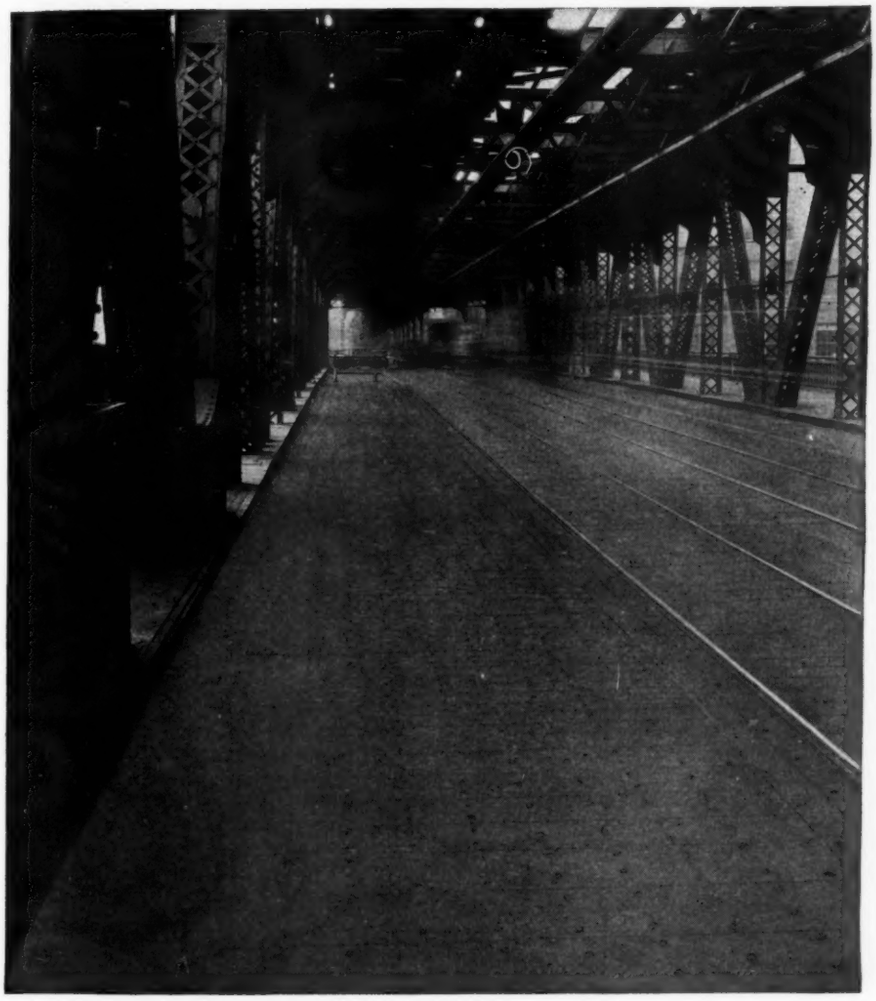


Cincinnati Gasoline Locomotive.

A New Permanent Sewer Pipe Joint Material

The Standard Oil Co., (Indiana), Chicago, Ill., has brought out an asphaltic product for making leakproof sewer pipe joints. This product

They are investigating it, using it, recommending it



The heavily traveled Lake Street Bridge, Chicago . . . impervious to its thousands of traffic thumps because it is surfaced with Carey Elastite Asphalt Plank.

..this unique *new* surfacing!

A REMARKABLE traffic surface that knits and heals—seems actually to *improve*—under the impact of heavy traffic. A flooring that quiets truss noises and lessens structural vibration. Seemingly indifferent to weather—firm under searing sun, non-brittle in bitter mid-winter. Carey Elastite Asphalt Plank!

Made of Carey-blended asphalts, minerals and selected fibres. Low in first cost—low in long-run maintenance. Get acquainted—write for full details.

Carey Elastite

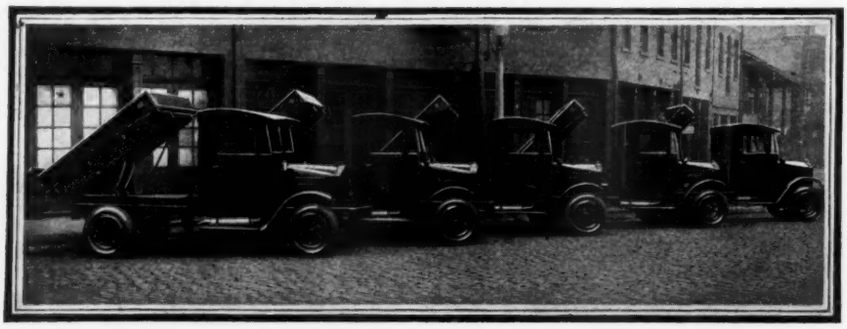
ASPHALT PLANK

"Knits and Heals under Traffic"

THE PHILIP CAREY COMPANY, *Lockland,* CINCINNATI, OHIO

is known as No. 1 Korite (Brand 6775). It is said to make a permanent, tight joint, and to prevent the leakage, infiltration and choking of pipes by roots. It is quickly prepared for use, and easily applied by an intelligent laborer.

It has been used on sewer pipe installations in various localities and found to be superior in many ways to cement. Tests conducted by the engineers of the Clay Products Associations have proved that the No. 1 Korite is a satisfactory material for making a permanent, leak-proof joint.



This fleet of 1½-ton Leudinghaus dump trucks has been purchased by the Missouri State Highway Department. The bodies are the Wood type L-4, 1½-yard capacity, with hydraulic hoists.

The Advantages of the Mechanical Distribution of Cover Material

From a paper by H. Norman Bechtel at the Southeastern Road Show.

Spreading cover material mechanically is fast becoming an approved and even demanded method. The advantages are many. More uniform distribution is obtained resulting in a surface giving longer wear, with less patching maintenance required. Small stock piles are no longer necessary, eliminating a menance to traffic on narrow roads and the inconvenience to residents on city or town streets. This eliminates the waste caused by heavy rains washing a portion away, frequently into drains and sewers, which must be cleaned at a great expense, and in no case is the full amount useable.

The saving effected by uniform distribution and the elimination of wasteful stockpiles has prompted engineers to reduce their cover requirements 20 to 25%. It is a fact that mechanical distribution will cover a surface thoroughly with 20% less material than hand spreading, and the saving thus effected can be added to the labor saved. One county engineer last year saved his county $4,000 by reducing the amount of cover material 20% of the quantity used by hand spreading.

The mechanical spreader is operated with only 2 men as compared to the usual large number used for casting by hand. For instance, if a normal day's work consists of eight 1,000 gallon tank loads of oil to be applied at the rate of ¼ gallon with 25 pounds of cover per square yard, this means that 32,000 square yards of surface will require 400 tons of cover material. This can easily be applied by a mechanical spreader in one day. Using hand labor this quantity would require 22 laborers, while with the modern method of mechanical distributing, but 2 laborers are needed. When delays occur only 2 men are idle instead of 22, thus creating another source of saving.

Mechanical spreaders can be used to cover road oil, asphalt or tar surface treatments, penetration and seal coats and to cover bleeding surfaces, broadcasting screenings on waterbound macadam, sanding bituminous concrete, distributing Calcium Chloride for dust laying, shells or gravel for maintenance or sanding slippery pavements.

Mechanical spreaders can be divided into two general classes: Those for spreading in thick layers and for spreading cover material; but, for the purpose of this discussion, only those for spreading cover materials will be considered. At the present time there are several types of this class of spreader on the market, each with distinct characteristics.

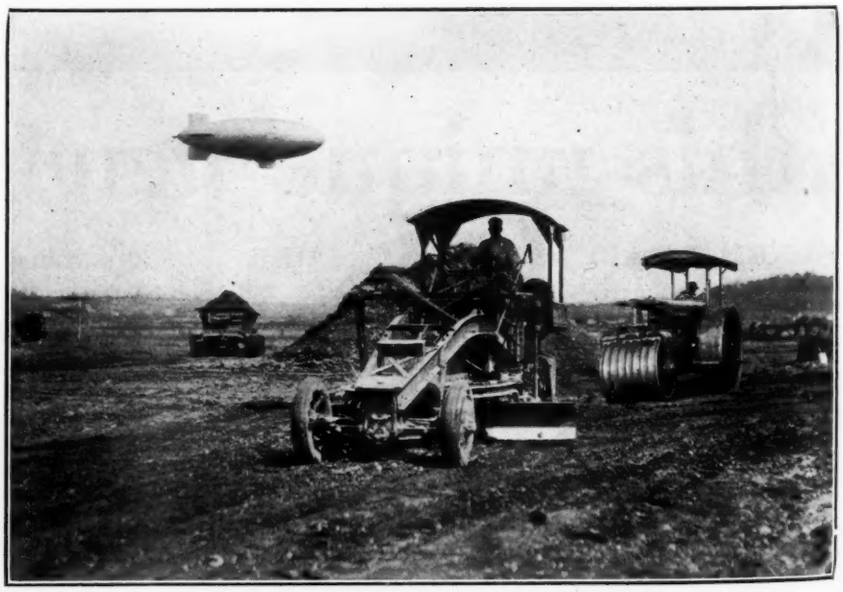
In view of the range of choice, it is well to sum up what features are desirable in a mechanical spreader. Practical use has developed these necessary features which should be made a part of all specifications for the purchase of spreading equipment as covered by the following: Light in weight but rugged construction; small in size requiring but little storage space when not in use; attachable to any truck with adjustments easy to make; instant control of amount spread per square yard; control of width spread; ability to spread in advance of itself and propelling vehicle; spreading capacity not less than 50 pounds per square yard; daily spreading capacity not less than 400 tons; ability to spread loose aggregates up to inch and one-quarter sizes.

Air Port Construction at Akron

The Akron, Ohio, municipal airport is to be a combined lighter-than-air and heavier-than-air field. It is located about 3½ miles southeast of the city of Akron. It will cover, when completed, approximately 700 acres. On one end of the port the hangars for the Goodyear Zeppelin Corporation are being erected in which two 6½ million cu. ft. airplane carrying Zeppelins will be constructed.

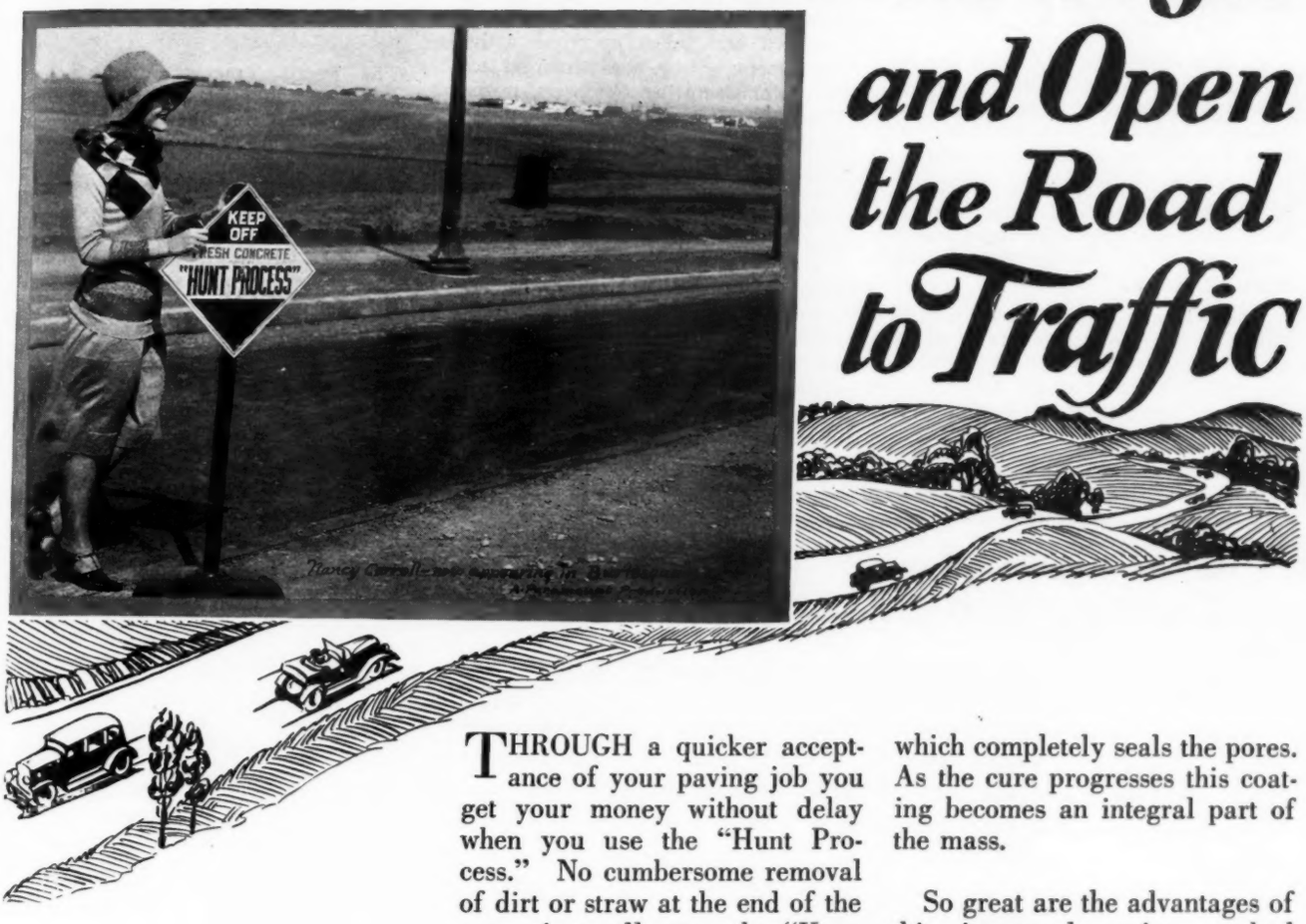
Cable Bros. of Canton, O., have the contract for the dirt moving and leveling of the field. The illustration shows a Galion motor grader and a Galion master roller owned by them at work on the field. One of the Goodyear Blimps is also shown making an inspection tour of the work.

The port is to be completed about January, 1930. A temporary landing field on the port is now used by the Continental Air Lines, flying between Cleveland and Louisville, Ky. B. E. Fulton is Manager of the Airport and the construction is under the direction of Fred E. Swineford, Director of Public Service of the City of Akron, O.



Work at Akron Municipal Air Port.

Just Take Down the Sign and Open the Road to Traffic



THROUGH a quicker acceptance of your paving job you get your money without delay when you use the "Hunt Process." No cumbersome removal of dirt or straw at the end of the cure—just roll away the "Keep Off" sign and let them on! And at the same time your concrete will be actually stronger—offer greater resistance to abrasion.

By preventing evaporation of the original mixing water the "Hunt Process" effects a complete crystallization and a perfect cure results. This is done by spraying the fresh concrete a few yards behind the mixer with a special asphaltic preparation which completely seals the pores. As the cure progresses this coating becomes an integral part of the mass.

So great are the advantages of this improved curing method that it has swept to national recognition almost over night! The first application was made only three years ago. Yet today, enough concrete has been cured by the "Hunt Process" to make a standard 20-foot pavement 500 miles long. An inquiry on your letterhead will bring you a copy of our illustrated booklet, "Curing Concrete Without the Use of Dirt and Water by the Hunt Process."

McEVERLAST, INC.
[TM.REG.]

111 West Seventh St. **Los Angeles, Calif.**

Branches:

35 E. Wacker Drive, Chicago, Ill. **1754 Graybar Bldg., New York, N. Y.** **1314 Magnolia Bldg., Dallas, Texas**

***Offices in:*—Kansas City, St. Louis, Boston, Phoenix, Pueblo, Seattle, Honolulu, San Francisco, El Paso, Oklahoma City.**

Industrial Notes

The California Filter Co. have removed to 981 Folsom St., San Francisco, Calif.

E. N. Gachenbach, 30 Church St., N. Y., has been appointed distributor of Overnight high early strength portland cement, which is manufactured by the West Penn Cement Co., Butler, Pa.

The Smith Trailer Corp., Syracuse, N. Y., have announced that "Amsco" track units are now being used on all their models of crawler type bottom dumping trailers

The Chicago district and Central Division Offices of various units of the Union Carbide and Carbon Corporation moved to the Carbide and Carbon Building at Michigan Avenue and South Water Street, Chicago.

The Concrete "Form-Hold" Corporation, Culver City, Calif., due to the growth of business, has been merged with the American "Farm-Hold" Corporation of Delaware.

Neil C. Hurley and J. F. Roche, operating as a company, known as the Chicago Utlities Corporation, have purchased and taken over the active management of the newly reorganized Binks Manufacturing Company, manufacturing a complete line of Spray Painting Equipment and Spray Cooling Systems. This company was formerly known as the Binks Spray Equipment Company.

A new service has recently been inaugurated by the Michigan Valve and Foundry Company, Detroit, Mich., whereby technical advice is made available to those in charge of projects involving water supply and distribution, drainage and sewage works, particularly where piping is an important factor. The administration of this service has been turned over to Eldon S. Clark.

The American Cast Iron Pipe Co., Birmingham, Ala., has moved its New York office to 117 Liberty Street.

James E. Dunn has been appointed district engineer of the Portland Cement Association at Nashville, Tennessee.

The Ferris Tractor Company has been formed in Dallas, Texas, to distribute the full line of United Tractor and Equipment Corporation tractors, farm implements and industrial equipment in North and West Texas. Executives of the new company are J. W. Ferris, president, F. A. Ferris, vice-president, and H. L. Burleson, manager.

Industrial Brownhoist Corporation of Cleveland has purchased The McMyler Interstate Company of Bedford, Ohio. The McMyler plant, machinery, and materials are not included in the purchase, but manufacturing operations and the business of the McMyler Company, together with all drawings and records, are to be moved to the Cleveland Plant of the Corporation. Through this purchase, Industrial Brownhoist acquires products supplementary to their own, both of which lines have been widely used for many years.

The H. O. Penn Machinery Co. have removed their offices and warehouse from 18 West 45th St., New York City to the Port Morris Terminal, 140th St. and East River, N. Y. This company handles the agency in the New York and surounding territories for construction and road equipment including Byers shovels and cranes, Rex paving equipment, Butler bins, OK hoists and compressors, Case rollers and other products.

New York offices of The Thew Shovel Company and The Universal Crane Company have been moved from 1706-30 Church Street and 408-30 Church Street respectively, to 2513 Chanin Building. The Chicago offices of The Universal Crane Company and The Thew Shovel Company have been moved from 1003 Transportation Building and 1432 Monadnock Block, respectively, to Builders Building, Room 2046, 228 N. LaSalle Street.

Recent Novo distributors, handling the Novo hoists, drag lines, engines, pumps, lighting units and similar equipment, include: Jersey Contractors Equipment Co., Plainfield, N. J.; Fitzgerald & Hudson, 150 Nassau St., New York City., N. Y.; Fred Lemcke. Park and Liberty Ave., Jackson, Mich.; Wylie Bros., Inc., Tulsa, Okla.; R. L. McDonald, Inc., Springfield, Mo.; Anderson Tractor & Equipment Co., Biltmore, N. C.; Tennessee Tractor Co., Nashville, Tenn.; Mine & Smelter Equipment Co., Phoenix, Ariz.; Lund & Co., Salt Lake City., Utah.; Krantz-McCelland, Inc., 522 Brvant St., San Francisco, Calif.,

Unit Costs of Construction

Waterworks Improvement

(Norton, Kans.)

Date of Contract—March 29, 1929

Cost of laying pipe:

No. of Feet	Kind of Pipe	Size	Average Depth	Cost per linear ft.
3,735	DeLaVaud	6″	4 ft.	$1.19
3,291	DeLaVaud	8″	4 ft.	1.56
2,252	DeLaVaud	10″	4 ft.	2.10
197	DeLaVaud	12″	4 ft.	2.63

(Note: These figures include the cost of trenching and back filling).

Hydrants	Size	Cost
1	4″	$66.25
17	6″	67.10

(Note: These prices include cost of installation).

Cost of 250,000-gallon supply tank: $17,500.
Total Contract Price: $40,158.18.
Consulting Engineer: Chas. A. Haskins, Kansas City, Missouri.
Contractor: Noah Garrett, Norton, Kansas.
Tank and tower purchased from the Pittsburgh-Des Moines Steel Company, Des Moines, Iowa.
Information furnished by Edna L. Guthrie, city clerk.

(Kansas Municipalities)

Sewer Construction

Salina, Kans.

Date of Contract—March 18, 1920

Cost of trenching and back filling:

No. of Feet	Average Depth	Kind of Soil or Rock	Cost
1,360	0′- 4′	Loam and Sand	$0.35
1,870	4′- 6′	Loam and Sand	0.45
1,010	6′- 8′	Loam and Sand	0.55
45	8′-10′	Loam and Sand	1.00
25,000 cu. yds. excavation, cost per cu. yd			0.70

Cost of laying sewer pipe:

No. of Feet	Kind of Pipe	Size of Pipe	Cost per Foot
1,950	Segment Block	72″	$13.00
1,775	Segment Block	66″	9.00
50	Segment Block	60″	8.15
1,532	Segment Block	54″	6.80
619	Segment Block	48″	5.80
845	Segment Block	42″	5.02
834	Segment Block	36″	4.03
45	V. S. P.	21″	2.25
385	V. S. P.	18″	1.63
2,495	V. S. P.	15″	1.23
1,310	V. S. P.	12″	0.85

(Note: These prices do not include the cost of trenching and back filling).

Cost of Constructing 15 Manholes, 8 ft deep, per each $60.00
Cost of Constructing 12 Manholes, 6 ft. deep, per each 60.00
Cost of labor, per day 3.20
Total Contract Price: $106,972.22.
Contractor: H. J. Taylor Construction Co.
Information furnished by: R. J. Paulette, city engineer.

(Kansas Municipalities)

California, Division of Highways

AVERAGE CONTRACT PRICES, JULY 1, 1921, TO JUNE 30, 1928

July 1 to June 30,	*Grading (per cu. yd.)*	*Asphalt concrete including all materials (per ton)*	*Concrete pav'mt. including all materials (per cu. yd.)*
1921.....1922.....	$0.71	$7.92	$14.29
1922.....1923.....	0.74	8.10	13.18
1923.....1924.....	0.75	7.27	13.49
1924.....1925.....	0.59	6.43	10.85
1925.....1926.....	0.44	5.13	10.58
1926.....1927.....	0.50	5.68	10.74
1927.....1928.....	0.56	4.70	10.23

State of Rhode Island, Board of Public Roads

Contract 2901, Warwick-Cranston Post Road. Bids opened April 3, 1929

Sheet Asphalt on Concrete Base

(1) Lane Constr. Corp., Meriden, Conn. (awarded contract;) (2) Greany & Sherry, Inc., Fall River, Mass.; (3) C. W. Blakeslee & Sons, New Haven, Conn.; (4) Joseph McCormick, East Providence, R. I.; (5) A. D. Bridge's Sons, Inc., Hazardville, Conn.; (6) Bruno & Pettiti, Boston, Mass.

	(1)	(2)	(3)	(4)	(5)	(6)
36,157 Cu. yds. Earth Excavation	$0.05	$0.40	$0.35	$0.44	$0.45	$0.80
111,600 Sq. yds. Cement conc. base course.....	0 95	1.00	1.10	1.10	1.26	1.50
111,600 Sq. yds. Sheet Asphalt Pavement.....	1.30	1.30	1.30	1.30	1.26	1.30
151,802 Sq. yds. Trimming and fine grading....	0.05	0.02	0.04	0.025	0.05	0.04

Totals—(1) $260,497; (2) $274,178; (3) $286,567; (4) $287,544; (5) $305,092; (6) $347,477